THE OLIGOCENE FLORA OF THE BOVEY TRACEY LAKE BASIN, DEVONSHIRE

BY

MARJORIE E. J. CHANDLER

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THE OLIGOCENE FLORA OF THE BOVEY TRACEY LAKE BASIN, DEVONSHIRE

By M. E. J. CHANDLER

SYNOPSIS

The Bovey Tracey lignite deposit suggests an accumulation of plant débris much of which was swept from a steep warm valley into an isolated lake basin lying in Palaeozoic strata. The lake was surrounded by marshland and tree-covered slopes which contributed to the fossil flora. Previous work on the beds and their plant remains is shortly reviewed, and in a few instances earlier determinations have been corrected. New material has been identified. The rich abundance of *Sequoia, Osmunda* and *Calamus* is noted and there are a number of other species represented by a few specimens only. Attention is called to the possibilities inherent in the study of pollen from Bovey. Thirty-one families are listed from fruits and seeds and there are at least thirty-eight species.

Many Tertiary species have a long range in time and cannot therefore be useful in determining age. But the slow replacement of some species and genera by others with the passing of successive Tertiary stages may afford a clue. The age which such evidence suggests for Bovey is Middle Oligocene.

INTRODUCTION

A revision of the fossil flora of Bovey Tracey is long overdue. Hitherto, knowledge of the deposit has been based largely on the work of Heer (1862) and Pengelley (1863) and to a lesser extent on that of C. & E. M. Reid (1910). The first-named workers carried out an exhaustive examination of the beds at a time when the coal pit of Bovey Tracey was accessible owing to economic enterprise. Peculiarly good exposures were then available. The sections were described by Pengelley and the flora by Heer.

When the Bovey pit was no longer worked for fuel it became largely obscured owing to flooding and to the growth of vegetation on the upper slopes. Yet C. & E. M. Reid were able to procure material from sections near the surface of the pit to which they added a few fruits collected in a newer pit at Heathfield owned by Messrs. Candy & Co. They also re-examined what remained of Heer's material, and published a revised account of the flora in 1910.

Shortly before the first world war the old Bovey pit was again worked, this time by a German firm, but since 1914 it has remained untouched. E. M. Reid and Chandler visited it again in 1932. Certain species were then available in rich abundance (*Sequoia, Osmunda,* and *Microdiptera* an extinct genus of Lythraceae) in some shaley beds just above the water line. There were also seeds in somewhat

greater variety in sandy beds a few feet higher in the section. Both levels were at the western end of the pit where at the very top a few seeds of *Stratiotes* were obtained. The eastern end of the south face was also exposed but was so deeply weathered that it yielded nothing. In a pit at Kingsteignton *Sequoia* was found but here there was little time for prolonged search. In Candy's pit at Heathfield which was still operated there were some good seeds and fruits in clays above a well-marked lignite band. The clays known to the firm as " best black clay " were examined on the spot and blocks kindly supplied later by Messrs. Candy were washed and sifted. Samples supplied from the middle and lower beds at that time exposed were unproductive. Thus almost all the plants at present known come from the two large pits at Bovey and Heathfield.

These Devonshire lignitic beds differ from all other plant-producing localities in the South of England Tertiary Beds in that they occur in isolation in a deep rock-basin formed of Palaeozoic strata. Other plant beds lately examined are interbedded among marine strata and so can be dated within certain limits at least by marine organisms. The Bovey basin is shown in the 1-inch Geological Survey Map (26th sheet), reproduced by Pengelley, as about 8 miles in length with a maximum breadth of about $3\frac{1}{2}$ miles. It is filled by gravel, sand, and pottery clays with abundant seams of lignite. The nature of these deposits indicates their derivation from decayed Dartmoor granites. C. & E. M. Reid (1910) state that the tectonic rock-basin is " surrounded on every side by steep bluffs which immediately to the northwest slope upwards into the heights of Dartmoor ".

Examination of borings by Reid suggested that throughout the great thickness of the beds, exceeding 500 feet, the same flora occurs so that they appear to belong to a single geological series. The beds near the surface at Bovey appeared to be equivalent to those near the base of the boring at Heathfield which penetrated for 526 feet without reaching the bottom of the basin. Among the sediments are masses of wood and other plant remains. Some may have been swept down from higher ground, but the greater part are presumed by the Reids to have been derived from the slopes of a forest-clad steep warm valley leading from Dartmoor and disgorging, in the neighbourhood of the Bovey pit, into the old lake basin. *Sequoia* is easily the dominant element in the vegetation of this valley. Ferns, such as *Osmunda*, apparently flourished in the ravine or around the lake. Recent work shows the presence of other marsh plants e.g. *Caricoidea* (Cyperaceae), *Myrica*, *Microdiptera* and *Lysimachia*. True aquatics are represented by *Salvinia*, *Stratiotes*, *Potamogeton* and *Brasenia*. Climbing plants are represented by vines and *Rubus*. Trees and shrubs such as *Nyssa*, the Lauraceae, *Symplocos*, *Carpinus*, *Magnolia* and *Meliosma* probably overhung the water and dropped their fruits into it. The Heathfield pit which lay nearer to the centre of the lake is less rich in *Sequoia* than the Bovey pit, and shows a greater variety of types. Prolonged collecting by a local enthusiast might prove very profitable here.

On the whole the flora is very limited but there is a great abundance of some few forms, rarer species being represented by one or a few individuals only. This may well be because dense *Sequoia* forests and *Calamus* jungle do not provide a congenial habitat for a wide range of plants.

PREVIOUS WORK ON THE FLORA

Although Heer described nearly sixty species, many of his determinations are unsatisfactory as judged by modern standards. Some because his material was poorly preserved or fragmentary as in the case of many of his leaves. This was recognized by Heer himself as a cause of some uncertainty. In certain instances his study of better material was too superficial, the possibilities inherent in intensive detailed research being then not so well understood as they are at the present time. Again to some extent comparable living forms were probably unknown. In spite of these disadvantages, and to his lasting credit, a number of Heer's species have stood the test of later critical study while it has now been possible to correct a few erroneous determinations. A revision of Heer's leaves cannot be attempted in this present work more especially as most of his specimens have decayed or seriously deteriorated.

There are a few corrections also of the determinations made by C. & E. M. Reid as will be apparent from the synonyms at the head of some descriptions in the systematic part of this work. One or two plants named by them are omitted—the evidence being inadequate—viz. *Taxodium distichum* (which may have been a peculiarly preserved *Sequoia* cone-scale), *Taxus baccata*, *Calla* cf. *palustris*, *Sagittaria* sp.?, Labiatæ, Genus?, and *Cornus*.

In the following pages only earlier records about which there is additional evidence and new additions to the flora based on fresh and reliable evidence are included.

A recent source of knowledge which calls for a separate study may be mentioned, namely pollen. In 1932 Reid and Chandler obtained a few anthers from which pollen grains were extracted, identified and photographed by Dr. J. B. Simpson. These are included in this paper.

In 1950 the late Nils-Erik Ross examined a sample of lignitic clay. He wrote from Uppsala (June, 1950) " The sample from Bovey contained an interesting micro-flora. There are plenty of pollen-grains of *Calamus* indicating a dense *Calamus* jungle at the time of the sedimentation of the clay. Other specimens of pollen and spores I have provisionally determined as ? *Picea*, *Pinus* (several spp.), *Podocarpus*, *Engelhardtia* (pollen-grains and star hairs from the cuticle), *Myrica*, *Symplocos* (2 spp.), *Ilex*, *Quercus* (comparable with some evergreen spp., e.g. *Q. ilex*), cf. *Tilia*, Ericaceae, Ulmaceae, Caprifoliaceae, ?Anacardiaceae, *Osmunda*, Schizaeaceae, etc."

Although Ross's evidence has not been published, it is interesting to note in passing that it confirms the determination of *Calamus*, *Myrica* and *Symplocos* from other organs, gives support to Simpson's *Tilia* and confirms Heer's *Quercus* and Ericaceae (the two last based on leaves).

The record of *Engelhardtia* is of interest because of its occurrence in the Oligocene Bembridge Beds. Schizaeaceae range from the Palaeocene to the Bembridge but it may be recalled that the Oligocene species of *Anemia* is different from that of the Lower Bagshot and Lutetian (Bournemouth Freshwater Beds). It would be helpful to know what genera and, if possible, what species Ross found of this family at Bovey. Dr. J. W. Franks of the British Museum (Natural History) is presently continuing the study of Bovey pollen and it is hoped that the important results of Ross's investigations will be included in a forthcoming paper with additional evidence.

THE MODE OF PRESERVATION OF THE FOSSILS

All specimens collected in recent years are carbonaceous entities. In the majority of cases they are separable from the matrix of clay or sand only after prolonged boiling with soda. All appear to have undergone intense compression so that they are not only distorted and flattened but frequently the carpellary coats or testa have been so carbonized that they break with a glassy fracture and the cell structure may be more or less obliterated in many cases. So far as the fruits and seeds are concerned the best specimens are not found in the lignite bands themselves but are associated with the interstratified beds. It should, however, be noted that in Ross's letter he asked for samples of pure lignite in which, he stated, the pollen grains are much better preserved than in clays. It was clear when collecting in the Bovey pit in 1932 that the richest variety of fruits and seeds occurred in the coarser sandy beds. This is commonly the case in Tertiary deposits, for in sandy beds the seeds and other remains are less distorted and more readily released and therefore less liable to be damaged. Unfortunately sandy exposures are very restricted in extent.

The laminated clay beds chiefly enclosed masses of matted *Sequoia* and *Osmunda* at the horizons lately available, and very little else. Prolonged search of the washings from such layers were rarely rewarded by any new discovery and were discontinued.

The leaves described by Heer were, in all probability, impressions with mummified leaf-substance. Such at least is suggested by the mode of preservation of the abundant *Sequoia* and *Osmunda* remains.

A revised list of Bovey plants is given below :

Family and its approximate climatic range, after R. Good. ct = tropical or chiefly tropical. tc = temperate or chiefly temperate. *b* = both tropical and temperate.		Genus and species	Other fossil occurrences in the South of England
Osmundaceae	b	*Osmunda lignitum* Giebel	Bournemouth Freshwater.
Salviniaceae	b	*Salvinia boveyana* n. sp.	Genus, Lower Headon.
Taxodineae	tc	*Sequoia couttsiae* Heer	Palaeocene ? Lower Bagshot (Studland) to Hamstead Beds (Hamstead).
Potamogetonaceae	b	*Potamogeton tenuicarpus* C. & E. M. Reid	Hamstead Beds.
Hydrocharitaceae	b	*Stratiotes websteri* (Bgt.)	Hamstead Beds.
Cyperaceae	b	*Caricoidea nitens* (Heer)	
Calameae (Palmae)	ct	*Calamus daemonorops* (Ung.)	Bournemouth Freshwater ; Cliff End, near Mudeford.
Zingiberaceae	ct	*Spirematospermum wetzleri* (Heer)	Lower Headon to Bembridge.
Myricaceae	b	*Myrica boveyana* (Heer)	
Betulaceae	tc	*Corylus* sp.	
		Carpinus boveyanus (Heer)	Bournemouth Marine ; Cliff End ; Lower Headon.
Fagaceae	tc	*Fagus minima* n. sp.	
Ulmaceae	tc	*Zelkova boveyana* n. sp.	

Family and its approximate climatic range, after R. Good. ct = tropical or chiefly tropical. tc = temperate or chiefly temperate. *b* = both tropical and temperate.		Genus and species.	Other fossil occurrences. in the South of England.
Moraceae	ct	*Moroidea boveyana* n. gen. et sp.	Genus, Lower Headon.
Nymphaeaceae	b	*Brasenia ovula* (Bgt.)	Bournemouth Marine to Hamstead.
Magnoliaceae	b	*Magnolia boveyana* n. sp.	Genus, London Clay and Bournemouth Freshwater Beds.
Lauraceae	ct	Various genera not determined	Palaeocene to Lower Headon, Bembridge.
Capparidaceae	ct	*Capparidispermum boveyanum* n. gen. et sp.	Family, Lower Bagshot to Bartonian.
Hamamelidaceae	tc	2 spp. or genera	Family, Palaeocene to Lower Headon.
Rosaceae	tc	*Rubus microspermus* C. & E. M. Reid	Upper Headon.
Leguminoseae	b	Genus ?	
Rutaceae	ct	*Rutaspermum exaratum* (Heer).	Genus, London Clay to Upper Headon.
Sabiaceae	ct	*Meliosma reticulata* (C. & E. M. Reid)	Genus, London Clay; Lower Bagshot (Lake); Bournemouth Freshwater Beds.
Vitaceae	ct	*Parthenocissus britannica* (Heer)	Genus, London Clay to Lower Headon.
		Parthenocissus boveyana n. sp.	
		Vitis hookeri Heer	Genus, Palaeocene to Lower Headon.
		Vitis stipitata n. sp.	
Tiliaceae	tc	*Tilia* sp.	Bournemouth Freshwater.
Lythraceae	b	*Microdiptera parva* n. gen. et sp.	Bournemouth Marine Bed Lower and Upper Headon.
Nyssaceae	b	*Nyssa boveyana* n. sp.	Genus, London Clay.
Myrtaceae	ct	*Myrtospermum boveyanum* n. gen. et sp.	Family, Palaeocene to Upper Headon.
		Myrtospermum dubium n. sp.	
		Myrtospermum sp.	
Mastixioideae	ct	*Mastixia boveyana* n. sp.	Family, London Clay to Lower Headon. Genus, London Clay.
Primulaceae	tc	*Lysimachia boveyana* n. sp.	
Symplocaceae	ct	*Symplocos anglica* n. sp.	Genus, Oldhaven to Lower Headon.
		Symplocos headonensis Chandler	Species, Lower Bagshot to Lower Headon.
Solanaceae	b	*Solanispermum reniformis* n. gen. et sp.	Lower Bagshot to Bournemouth Marine and Cliff End Beds.

The grouping of the families into tropical or chiefly tropical, temperate or chiefly temperate, and both tropical and extratropical is based on R. Good's classification (1947). It is inevitably to some extent arbitrary. Thus it might be argued should the Magnoliaceae, Lauraceae and Vitaceae be classified as chiefly tropical or wide-ranging in that they have extensions into cooler regions ? or should the Rosaceae and Hamamelidaceae be grouped as temperate or wide-ranging for they have limited extensions into warmer areas? On the whole, however, the grouping appears to give a representative picture and suggests a warm flora, for of thirty-one families, eleven are chiefly tropical and only eight temperate. But for reasons shortly to be stated these figures should not be unduly stressed. In this connexion it may be noted that certain genera of temperate type e.g. *Sequoia*, *Carpinus*, are associated in Eocene beds with a well-defined warm flora so that, in the past, they may have had extensions into subtropical or tropical climates which have been lost at the present day. Families such as Hamamelidaceae still retain limited extensions; hence their presence in a warm flora is not surprising. Further, the constant association in the fossil record [in part awaiting publication] of the genus *Microdiptera* and the species *Solanispermum reniformis* with warm floras points to them as warm representatives of the wide-ranging families Lythraceae and Solanaceae.

THE AGE OF THE BOVEY FLORA

Palaeobotanists have differed considerably in their views on the age of this isolated undated deposit.

Heer, although on slender evidence, equated the Bovey lignites with the Middle Oligocene Hamstead Beds of the Isle of Wight (1862*a*). Gardner (1879 : 18) regarded the flora as identical with the Eocene Bournemouth Freshwater Beds with which, it is true, they have a number of genera in common e.g. *Osmunda*, *Calamus*, *Stratiotes*, *Magnolia*, *Rubus*, *Meliosma*, *Vitis*, *Mastixia* and *Symplocos*.

C. & E. M. Reid (1910) compared the flora with that of the Wetterau. Reid & Chandler (1926 : 25–28) used the percentages of *European* genera present in a series of floras ranging from Eocene to Pliocene among which was Bovey with 38% (so far as it was then known). They reached the conclusion that the Bovey flora was approximately of Middle Oligocene age and was considerably younger than the Upper Eocene Hordle flora, and older than the Mio-Pliocene and Pliocene floras of Pont-de-Gail and Reuver. The figure for Bovey would now be more like 44% still well below that for the Pliocene (47–58%). It cannot, however, be stressed too emphatically that in dealing with small floras of relatively few genera and species statistical methods may not be wholly satisfactory. A few new finds or fresh determinations can alter the figures appreciably. It therefore seems inadvisable to lay too much stress upon such methods in cases where the element of chance may influence results to a large extent.

Another point to be borne in mind is this : The utmost caution is needed in attempting to date one of the older Tertiary floras by its plant remains. Long research on Eocene and Oligocene plants has underlined the fact that many species have a far longer range in time than was once supposed. There are indications of

this in the Bovey table given on pp. 76, 77. Some examples are quoted here, using species found at Bovey.

Sequoia couttsiae is a typical instance. The species is well known from twigs, cones, seeds and cuticle. Its cuticular structure is distinctive. Its range in England is certainly from the Lower Bagshot to Hamstead Beds and may be from the Palaeocene.

Carpinus boveyanus is known in the Bournemouth Marine Beds, the Cliff End Beds and the Lower Headon, possibly also in the Upper Headon.

Solanispermum reniformis ranges from the Cuisian, through the Bournemouth Freshwater and Marine Beds to the Cliff End Beds.

A number of species not found yet at Bovey could also be used to illustrate the long range of some older Tertiary types. For example the following awaiting record or description which have been found in the Lower Bagshot of Lake or Arne, the Lower Headon of Hordle, and sometimes in intermediate beds : *Caricoidea obscura* (Cyperaceae), *Protoaltingia* (Hamamelidaceae), *Phellodendron, Natsiatum, Myrtoidea, Myrtospermum variabile, Styrax, Eomastixia, Mastixicarpum.*

It may be dangerous to rely on the presence or absence of particular species in trying to assess age, for it is impossible to determine the part played by chance preservation and discovery in the records of a flora.

Nevertheless time and further research may throw fresh light on the problem of Tertiary plants as time-indicators. There is already some hint that although long range of species is a common phenomenon, there is also a gradual replacement of some species or genera by others during a long period.

Up to the present (and it is necessary to stress this qualification) *Spirematospermum wetzleri* has not been found in this country below the Lower Headon (or possibly the Barton Beds). It occurs at Hordle, and in the Middle Oligocene Bembridge Beds. It also occurs at Bovey.

Brasenia ovula (Bgt.) appears in the Bournemouth Marine Beds and Hengistbury Beds and persists through the Barton, Lower and Upper Headon, Bembridge and Hamstead Beds. Below the Bournemouth Marine Beds in the Freshwater (Lutetian?) series and the Lower Bagshot, its place appears to be taken by another characteristic and readily recognizable water-lily (awaiting description) which disappears after the Lutetian. It is *Brasenia ovula* which occurs at Bovey.

Similarly, *Microdiptera parva*, an extinct genus of Lythraceae, occurs in the Bournemouth Marine Beds and the Lower and Upper Headon. In the Bournemouth Freshwater Beds there is a different species of *Microdiptera*. It is *M. parva* which occurs at Bovey.

These records suggest that the Bovey flora is not older than the Bournemouth Marine Series.

Again *Potamogeton tenuicarpus* is known in the Hamstead Beds (possibly also in the Upper Headon). On the other hand a highly distinctive spiny species, *P. pygmaeus* ranges, according to present knowledge, from the Bournemouth Marine Beds, through the Lower Headon only up to the Bembridge Beds, after which *P. tenuicarpus* is found. *P. tenuicarpus* is the species found at Bovey.

Stratiotes is a characteristic common Tertiary genus where water-plants are

preserved. The successive species appear to have a very limited range in time (Chandler, 1923). *S. websteri* (Bgt.), which occurs at Bovey, is found in the Hamstead Beds, also in the Oligocene Cyrena-Marls of Offenbach on the Main. It does not, so far as is known, range into the Miocene which is characterized by *S. kaltennordheimensis* Zenker. It is markedly different from the somewhat older Lower and Upper Headon species *S. headonensis* Chandler. In deposits older than the Lower Headon a much smaller species has now been found. It will be described as a variety of *S. zinndorfi* Kirch.

S. zinndorfi was thought by Kirchheimer to be Oligocene. The variety is of Eocene age and disappears before the Lower Headon. The occurrence of the large typical *S. websteri* at Bovey therefore supports a Middle Oligocene age for the deposit.

On the whole such evidence as there is indicates an Oligocene, and perhaps a Middle Oligocene age for the Bovey flora.

One other genus perhaps deserves special mention, viz. *Mastixia*. It, or its close allies, are among the most abundant Eocene plants ranging from the London Clay through the Lower Bagshot, Bournemouth Freshwater and Marine, Cliff End and Hengistbury Beds to the Bartonian and Lower Headon. So far they have not been found in the Upper Headon or younger beds.

According to Kirchheimer (1936 : 125), who based his conclusions on evidence from successive beds of the German Brown Coal, the genus disappeared in Europe after the Oligocene. The sparse occurrence of a species, quite specifically distinct from any of the British Eocene species, indicates, therefore, a pre-Miocene and post-Eocene age for the Bovey lignites.

Further work on Bovey pollen may serve to throw more definite light on this problem of age. At present there appears to be no other source from which information is likely to come.

In conclusion it should be recorded that the writer had the advantage of collaboration with E. M. Reid in the study of some at least of the material collected in 1932. The Introduction to this paper was seen and approved by the late Mr. W. N. Edwards shortly before his death and Mr. F. M. Wonnacott has given invaluable help in the preparation of the manuscript for the press.

PTERIDOPHYTA

Order FILICALES

Family OSMUNDACEAE

Genus ***OSMUNDA*** Linnaeus

Osmunda lignitum (Giebel)

(Pl. 11, figs. 1–6)

1862. *Pecopteris* (*Hemitelia* ?) *lignitum* Giebel : Heer, p. 1047, pl. 56, figs. 2–8.
1882. *Osmunda lignitum* (Giebel) : Gardner, p. 49 (reference to Bovey material).

DESCRIPTION. *Pinnules :* These have been fully described by Heer (1862).

Sporangia : Sub-globular, dehiscing longitudinally on one side from pole to

pole, the margins of the sutures formed by about three rows of narrow elongate longitudinally aligned cells. Walls elsewhere formed of a layer of thick-walled, usually longitudinally elongate cells, often about 0·025 by 0·05 mm. in diameter. Annulus a raised patch of thicker-walled more opaque cells at one pole adjacent to the distal end of the split, occupying about half the length of the sporangium. Diameter of sporangium about 0·45–0·55 mm.

Spores: Finely granular, sub-globular, tetrahedral, about 42 to 62 μ in diameter (actual measurements, 50 × 45 μ and 62 × 42 μ).

Remarks and affinities. Almost as abundant in the Bovey coal pit as *Sequoia* with which it is mixed in certain seams forming matted masses. Slabs of matrix from such seams are very fissile on drying so that they quickly disintegrate. In addition to a number of such blocks with barren fronds there are scanty remains of fruiting organs in the washed residues. The disc-like annulus points to the family Osmundaceae and to the genus *Osmunda*. Spores of the living *O. regale* appear to be somewhat thinner-walled with finer spines than those seen in the fossil. They measured 45 μ in diameter. Heer found no sori in spite of repeated search (1862 : 1047). Later his work was criticized by Gardner (1882 : 49) who identified the Bovey barren pinnules with similar specimens from Bournemouth, and with others from continental localities. Gardner pointed out that the absence of sori on the pinnules should have directed Heer's attention to *Osmunda* in which the fertile pinnules are segregated at the ends of the fronds.

The name *O. lignitum* has been used frequently for indistinguishable barren pinnules from widely scattered European localities. Probably, like *Sequoia couttsiae*, the species was wide-ranging in space and time in the older Tertiary. There seems no reason why the barren pinnules and isolated sporangia should not belong to a single species.

Family Salviniaceae

Genus ***SALVINIA*** Linnaeus

Salvinia boveyana n. sp.

(Pl. 11, figs. 7–11)

1910. Spadix of aroid ? C. & E. M. Reid, p. 173, pl. 16, fig. 57.

Diagnosis. Sporocarps sub-globular enclosing at least twenty to fifty globular male sporangia. Microspores tetrahedral, the majority 0·025 mm. (25 μ) in diameter, ranging from 0·02 to 0·03 mm. Vegetative parts unknown.

Holotype. A sporocarp. Brit. Mus. (N.H.), No. V.33834.

Description. *Vegetative parts:* Unknown.

Sporocarps: Sub-globular (incomplete). Walls thin, as shown by the manner in which the sporangia distort the wall (Pl. 11, fig. 7), structure obscure, but small equiaxial cells 0·006–0·009 mm. in diameter can be detected on the much corroded surface. In many places abrasion has actually exposed the sporangia so that their

cell-structure and contents tend to obscure and confuse the cell-structure of the sporocarp. As preserved the sporocarps enclose from about twenty to fifty sporangia, but there must originally have been more for all are incomplete.

Sporangia: Globular, thin-walled, 0·15–0·2 mm. in diameter, walls apparently one cell thick, formed of coarse polygonal cells. The cell-walls are obscure either because they have decayed so that they are represented by impressions only, or else because they are very thin. The sporangia are hollow in the middle, formed of a frothy substance within which the microspores occur in fours, each spore with characteristic triradiate markings. The average spore diameter is 0·025 mm. (25 μ) but some are as much as 0·03 mm., others 0·028 mm., a few only are smaller than 0·02 mm. and those are probably immature.

Remarks and affinities. Five sporocarps with numerous sporangia. The microspores agree closely in size with an unnamed species described by Kirchheimer (1931 : 102–113) from the Upper Miocene Brown Coal of Beuern in Vogelsberg (spore diameter 25 μ), also with *Salvinia hassiaca* Kirchh. from Garbenteich (spore diameter 26 μ), a species of similar age (1930*a* : 203). Among living species of which spore measurements are available, the nearest to the fossil is *S. auriculata* Aubl. (spore diameter 27 μ), a species from Central and South America and the West Indies. In the living *S. natans* (Linn.) the microspores measure only 18 μ, and in *S. ancillata* Roxb. 22 μ, while in *S. oblongifolia* Mart they measure 23 μ. These measurements are taken from Kirchheimer's detailed researches on the fruiting organs of fossil *Salvinia* in German Brown Coal (1931); there are other papers by this author on the fossil occurrence of the genus (1928; 1929; 1930; 1932; 1937). His investigations are concerned chiefly with Miocene material, but an Oligocene species was figured from the Niederpleis Brown Coal in 1937 (p. 897, text-fig. 4); unfortunately it does not permit of satisfactory comparison; the dimensions of the microspores were not given.

No fruiting organs have been described previously from Britain, but vegetative parts are known from the Lower Headon of Hordle (Chandler, 1925: 10, pl. 1, figs. 1*a–d*; text-fig. 1) and also occur in numerous continental localities (Florin, 1919 : 243).

The living genus *Salvinia* is distributed throughout the north temperate zone in the Old and New Worlds. It occurs also in the East Indies, Tropical Africa, the Mascarene Islands, South and Central America and the West Indies.

GYMNOSPERMAE

Order CONIFERALES

Family Taxodineae

Genus ***SEQUOIA*** Endlicher

Sequoia couttsiae Heer

1862. *Sequoia couttsiae* Heer, p. 1051, pl. 59; pl. 60, figs. 1–46; pl. 61.
1862*a*. *Sequoia couttsiae* Heer : Heer, p. 372, pl. 18, figs. 1–7.
1883. *Sequoia couttsiae* Heer : Gardner, p. 36, pl. 6, figs. 7, 10–17.

1910. *Sequoia couttsiae* Heer : C. & E. M. Reid, p. 170, pl. 15, figs. 23–27.
1921. *Sequoia couttsiae* Heer : Chandler, p. 457.
1922. *Sequoia couttsiae* Heer : Chandler, p. 385.
1923. *Sequoia couttsiae* Heer : Bandulska, p. 257, pl. 21, figs. 31, 32.

The external morphology has been well described and figured by Heer (1862, 1862*a*) and by C. & E. M. Reid (1910). It may be added here that the seed-body can be either straight or curved whereas Heer referred only to curved seeds. Twigs, cones, detached cone-scales and seeds are common at Bovey, and occur less frequently at Heathfield and Kingsteignton. The cuticle has been described and figured by C. & E. M. Reid (1910) and Bandulska (1923). New details of cuticular structure are here recorded.

The stomata are borne on both sides of the leaf.

Cuticle of upper surface : This has two well-marked stomatal bands one on each side of the midrib showing thickly scattered stomata variously oriented, a few being longitudinal or transverse but the majority oblique. They have a tendency to be arranged in short longitudinal rows, but this is not a conspicuous feature. In the broader parts of the leaves three or four, sometimes more, stomata may be arranged abreast. Three bands of epidermal cells occur outside the stomatal bands, a narrow band frequently about eight cells wide at each margin, and a broad median band over the midrib which may be about twenty-five cells wide at the leaf base. The marginal bands unite with one another and sometimes with the median band also at the apex of the leaf. Occasionally the median band dies out a short distance below the apex and then the two stomatal bands unite, or almost unite, just below the apex. Towards the leaf-tip the epidermal cells nearest the margin tend to diverge in a fan-like manner. Epidermal cells between the stomata very variable in form and size, frequently more or less equiaxial, not infrequently transversely elongate and aligned especially between stomata in the same longitudinal row. Stomata rarely share any auxiliary cells but are often sufficiently close together for the auxiliaries of adjacent stomata to be in contact without intervening epidermal cells. Stomatal pores oval to sub-quadrangular except on the decurrent flanges of the leaf where they may be sub-circular or broadly oval. Guard cells thinly cuticularized, the slit between them conspicuous, occasionally they show fine granulation. The outer pore ("aussere atemhöhle" of Florin) is normally about 0·02 mm. long, occasionally 0·03 mm. The auxiliary (= subsidiary) cells are considerably thickened where they unite with the guard cells, they vary from four to six and are arranged in a ring around the guard cells, often end to end, but there is a tendency to vary in size and shape so that the regularity of the ring is sometimes destroyed. Sometimes two concentric cells (or a cell which has divided into two by a longitudinal partition) occur in parts of the ring. The epidermal cells outside the stomatal bands are longitudinally elongate and aligned, in some leaves parallel-sided with rectangular or oblique end walls, in others tending to be broader at the middle than at the ends but such frequently have flat straight end walls. Cells brown and much cutinized with a fine inconspicuous reticulate thickening at least in some cells. At the base of the leaf the walls are always thin and colourless. Cells of the marginal epidermal band often appreciably broader than those of the middle. Typical leaves measured :

(1) length, 0·7 mm.; breadth, 1 mm.; (2) length, 0·64 mm.; breadth, 0·48 mm.

Cuticle of lower surface: Also has two stomatal bands which are broader and less sharply defined than those of the upper surface and do not extend so far towards the tip of the leaf. The bands broaden considerably towards the base where sometimes they almost merge, but at the extreme base they are reduced to one or two rows of large oblique stomata adjacent to the leaf margin separated by a wide triangle of thin-walled epidermal cells with large cavities. The stomata are more distant and widely scattered than those of the upper surface with a tendency to occur in short longitudinal lines often separated from neighbouring lines by several rows of longitudinal ordinary epidermal cells; they are transversely, obliquely, and longitudinally oriented, but on the whole oblique orientation appears to predominate. The " outer pore " may be oval but is frequently narrow-oval, usually about 0·02 mm. long or a little longer. The slit between the guard cells is clear. Auxiliary cells vary from four to six and are arranged in a ring around the " outer pore ", but there is a much more marked tendency for the cells in the ring to be uneven in length, shape, and size than on the upper surface. There is also a marked tendency for one or two of the cells to be prolonged into a row of ordinary epidermal cells adjoining the stoma and from these they can scarcely be distinguished. Auxiliary cells of adjacent stomata may be contiguous and are occasionally shared by adjacent stomata, more often, epidermal cells intervene. There is sometimes a double ring of auxiliary cells in part of the circumference. The auxiliary cells are not more conspicuously cutinized than the ordinary epidermal cells except where they abut on the guard cells; here there is a thickening of the wall. The ordinary epidermal cells in the stomatal bands are often irregularly arranged and are frequently as broad as long, sometimes longitudinally elongate and aligned, but often between two stomata in the same linear series transversely elongate and aligned. Marginal and median bands of ordinary epidermal cells unite below the apex to form a broad triangular apical area without stomata. The epidermal cells are frequently parallel-sided, longitudinally elongate and aligned; in the median band they often have rectangular or oblique end walls; in the marginal bands they are less frequently rectangular, usually also narrower and longer than in the median. Also in the median band they tend to be shorter at the apex of the leaf than below. In one slide they appeared to be beset with small pits, about 0·002 mm. broad, irregular in shape and distribution. They are occasionally very slightly sinuous, especially their transverse walls. Such sinuosities are seen often on the decurrent leaf base in the median band.

There is a greater resemblance to *Sequoia gigantea* in the arrangement of the stomata on the upper-side of the leaf than to *Sequoia sempervirens* owing no doubt to the greater similarity of form.

Remarks. The species has lately been recognized at Studland (Lower Bagshot), the Bournemouth Marine Beds of Southbourne, the Cliff End and Hengistbury Beds. It is also represented in the Lower Headon at Hordle, and the Upper Headon at Colwell Bay.

Detailed accounts and illustrations of these cuticles are included in a forthcoming monograph on the Lower Bagshot flora where the species is fully discussed.

ANGIOSPERMAE

Class MONOCOTYLEDONES

Family POTAMOGETONACEAE

Genus ***POTAMOGETON*** Linnaeus

Potamogeton tenuicarpus C. & E. M. Reid

(Pl. 11, figs. 12–14)

1910. *Potamogeton tenuicarpus* C. & E. M. Reid, p. 173, pl. 16, figs. 53, 54.

DESCRIPTION. *Endocarp:* Broadly obovate, originally somewhat inflated (now much flattened), curved through almost a complete circle about a circular or oboval central depression, the curved area forming the locule; dorsal margin semi-circular, ventral margin convex above and below, conspicuously indented between the ends of the limbs i.e. between the convexities at a distance of about one-third of the length from the base of the fruit; sometimes remains of a small spine can be seen just above the indentation. Style small, patent, terminal on the ventral margin. Surface conspicuously ridged, one ridge outlining the central depression, another the dorsal margin adjacent to the keel, a third down the middle of the keel; ridges sharp, forming small flanges. Keel broad reaching from the base almost to the apex, with a groove on each side of the median ridge. Surface cells irregular in shape with the long axes diverging from the central area but also showing an alignment parallel with the curvature of the endocarp; cells averaging in size about 0·012 by 0·02 mm. Length of endocarp, about 1–1·5 mm.; breadth, 0·75–1·2 mm.

Seed: (Formerly described as the embryo, C. & E. M. Reid, 1910.) Narrow, elongate, curved in accordance with the curvature of the locule; testa smooth, shining, light brown, semi-translucent, the square cells measuring 0·017 mm. across and aligned parallel with the direction of curvature.

Pollen: Preserved in detached anthers and determined by Dr. J. B. Simpson. Smaller than that of *P. natans*, finely reticulate all over with a marked invagination on one side of the grain exposed when the intine had been cleaned out (Pl. 11, fig. 14). Probably belongs to this species; the only one present.

REMARKS AND AFFINITIES. This species is re-described above in greater detail. The form and structure of endocarp, seed (and according to Dr. Simpson, pollen also) indicate the presence of a species of *Potamogeton*. The living *P. cristata* Regel & Maack is almost equally small but does not otherwise resemble the Bovey fruit. The breadth of the dorsal keel in the Bovey fossil shows that in life the locule was probably more or less triangular in cross-section, but the thin though coriaceous carpel has collapsed and been variously distorted by pressure in fossilization. The same species occurs in the Hamstead Beds of the Isle of Wight.

P. pygmaeus Chandler from the Upper Eocene of Hordle and the Oligocene Bembridge Beds, Isle of Wight, is distinguished by the normally smaller size, the convexity of the ventral margin with median prominence, and especially by the spines on the keel (bases only preserved except in impressions).

Family Hydrocharitaceae

Genus ***STRATIOTES*** Linnaeus

Stratiotes websteri (Brongniart)

(Pl. 11, figs. 15–19)

1862. *Carpolithes websteri* (Brongniart) : Heer, p. 1075, pl. 70, fig. 6.
1910. *Stratiotes websteri* (Brongniart) : C. & E. M. Reid, p. 172.
1920. *Stratiotes kaltennordheimensis* (Zenker): E. M. Reid, p. 60, pl. 3, figs. 8, 9.
1923. *Stratiotes websteri* (Brongniart) : Chandler, p. 128, pl. 5, figs. 10, 11 ; pl. 6, figs. 2, 3.

Description. *Seed :* Oblong with rounded ends, hooked or slightly sigmoidal in outline, laterally flattened. Keel narrow, beaked at the apex in sigmoidal seeds, usually rounded externally, not continued round the base but merging gradually into the collar. Collar usually large, rounded, testa woody ornamented over the body with interrupted longitudinal ridges which run from neck to apex where they curve towards the keel and converge to the raphe ; pitting fairly uniform on body, collar and sides of keel, typical pits measuring about 0·05 mm.; along the dorsal margin of the keel the pits are much finer. Keel broadening gradually towards the apex as seen in longitudinal section of the seed (Pl. 11, figs. 18, 19).

Micropyle basal or sub-basal, very slightly oblique, hilum dorsal, associated with the beak at the apex of the keel in the few specimens available. Raphe short, transverse. Digitate cells of the interior of the keel straight, parallel to the length of the keel.

Length of a large seed in Sedgwick Museum, Cambridge, 6·8 mm.; breadth, 2·75 mm. Length of a seed in the Geological Survey Collection 6·4 mm.; breadth, 3 mm. Length of a seed recently found at Bovey by the author, 5·25 mm.; maximum transverse measurement of a seed flattened dorsi-ventrally, 3 mm.

Remarks and affinities. One seed and fragments of three others showing respectively the raphe and the collar have been found lately at Bovey. Several specimens from other collections have also been examined. The seeds have been compared with specimens of *Stratiotes websteri* from the Hamstead Beds of the Isle of Wight and are indistinguishable from that species.

Family Cyperaceae

Section Caricoideae

Genus ***CARICOIDEA*** nov.

A form-genus for fruits or endocarps belonging to the section Caricoideae of the family Cyperaceae of which the nearer relationship is not known.

Caricoidea nitens (Heer)

(Pl. 11, figs. 20–23 ; Text-fig. 1)

1862. *Carpolithes nitens* Heer, p. 1078, pl. 70, figs. 15–23.
1910. *Taxus ? nitens* (Heer) C. & E. M. Reid, p. 172.

Diagnosis. Originally globose with triangular calyx about 2·4 mm. in diameter ; apex pointed, base with aperture closed by a plug about 0·8–0·9 mm. in diameter. Epicarp shining, formed by longitudinally aligned cells with straight or sinuous outlines. Endocarp 0·5–1 mm. thick. Diameter (crushed dorsi-ventrally), 4–5 mm.

Holotype. A laterally compressed fruit ; also figured by Heer (1862, pl. 70, fig. 20). Brit. Mus. (N.H.), No. V.33842.

Description. *Fruit :* Originally globose (now compressed sometimes laterally, at others dorsi-ventrally), apex somewhat pointed, base somewhat truncate having a triangular impression (as of a non-accrescent calyx), about 2·4 mm. in maximum diameter, at the centre of which is a circular scar closed by a plug about 0·8–0·9 mm. in diameter. Surface of fruit and triangular impression (except over the plug) shining, longitudinally striate (fine parallel striae varying in direction are the result

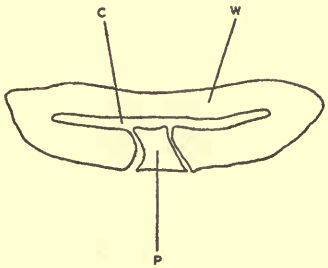

Fig. 1. *Caricoidea nitens* (Heer). Diagrammatic longitudinal section through specimen dorsiventrally crushed, showing the cavity (*c*), thick wall (*w*) and the plug (*p*) filling the basal canal. × 10.

of tensions in compression). This coat (epicarp) formed of irregular longitudinally aligned cells with straight or sinuous outlines, 0·05 mm. or less in length, 0·016–0·025 mm. in breadth. This coat appears vitreous as seen in section and is intimately fused with the subjacent wall. Endocarp, 0·5–1 mm. thick, formed of regular parenchyma ; cells, 0·012 mm. in diameter, the layers lining the cavity being vitrified. Locule small, often flattened by pressure, lined by irregular, slightly sinuous, thin-walled cells, 0·25–0·5 mm. in diameter, and in one specimen by a series of parallel transversely aligned cells (impression of testa or adherent testa). The locule communicates with the exterior by a canal about 0·5–0·8 mm. broad and is closed by the plug described above. Diameter of fruits, 4–5 mm.

Remarks and affinities. Seven fruits, two now broken. They are stated by C. & E. M. Reid in their photographic records to be the originals of Heer's figures (1862, pl. 70, figs. 15–23). It has been possible to identify the originals of figs.

16, 18 and 20, but the other drawings are too inaccurate in detail to permit of further identification of types.

In describing this species under the name *Carpolithes nitens*, Heer draws a comparison with seeds of *Taxus*. Later, C. & E. M. Reid (1910 : 172) refer the specimens tentatively to this genus. The evidence does not support this ascription. The characters indicate relationship with Cyperaceae, section Caricoideae (the shining exocarp, basal triangular scar, basal canal and plug, and thick parenchymatous wall). Similar surface cells occur in *Cladium mariscus* which differs in having a much smaller fruit. No genus which corresponds closely with the fossil has been found, while in most of the Caricoideae the exocarp is distinct from the wall of the nut and not indistinguishable from it. The apparent fusion of the two in the fossil is no doubt the result of the intense compression which has occurred.

Family Palmae

Sub-section Lepidocaryinae

Genus *CALAMUS* Linnaeus

Calamus daemonorops (Unger)

(Pl. 12, figs. 24–42)

1862. *Palmacites daemonorops* (Unger) Heer, p. 1056, pl. 55, figs. 7–15 ; pl. 60, figs. 50–53 ; pl. 62.
1910. *Palmacites daemonorops* (Unger) : C. & E. M. Reid, p. 172, pl. 16, figs. 44–49.

Description. *Spines :* (Pl. 12, figs. 38–41). Common, either single or attached to a piece of stem, especially at Bovey ; a few occur at Heathfield. They are black, shining, thin, tapering to a fine point, varying in length from 4 to 50 mm., the longest being only 3 mm. broad at the base. The spine has a shallow longitudinal furrow on one surface ; frequently the spines are grouped in threes of which the middle one is the longest. Often they are two, or solitary, while four, five, or even more may occur in a group. Heer stated that they were distributed on a finely striate, flat, minutely warty surface (Heer, 1862, pl. 55, figs. 11, 12 ; pl. 62, fig. 7). In the specimens recently examined this surface appears rough, formed of equiaxial cells about 0·025 mm. in diameter.

Fruiting axes (Pl. 12, figs. 35, 36) : Abundant, some with scars only to which bracts were formerly attached, others still carry striate overlapping bracts which are usually broken at their free edges.

Flowers : Dioecious, surrounded by stiff coriaceous bracts and bracteoles as in an amentaceous inflorescence. Male flowers (Pl. 12, figs. 32–34) with three pointed-oval bracts having valvate aestivation. Usually the stamens have been shed but one flower contained stamens with pollen. This was examined and photographed by Dr. J. B. Simpson. In letters of 27.iii.38 and 1.iv.38 he provided the following facts : " *Pollen.* Grains smaller than those of *Trachycarpus excelsis* (the only recent pollen available for examination) having a single furrow lined by a thin membrane as in *Trachycarpus*, the membrane sometimes preserved in the fossils

but at other times destroyed. Also having the same type of irregular reticulations in the exine " (see Pl. 12, fig. 42). In his preliminary statement on Bovey pollen grains the late Nils-Erik Ross reported abundant *Calamus*.

Female flowers or immature fruits : Numerous. One-loculed with three stigmas (Pl. 12, figs. 24–31). Better-developed specimens are ovoid or sub-globular (but much compressed in fossilization), having six bracts, usually free with imbricate convolute aestivation, arranged in two alternate whorls. Bracts longitudinally striate through the occurrence of sub-parallel conspicuous nerves. Surface of fruit formed by characteristic recurved scales of the Rotang palm type, frequently almost obliterated owing to the highly compressed state of the material. Surface of scales of oblong cells aligned in rows forming striae which diverge from the proximal end of the scales and fan out to their thin slightly fringed edges. Inner wall of fruit compact, formed of equiaxial cells 0·012–0·016 mm. in diameter.

Seeds : Not seen in a fully developed condition, but C. & E. M. Reid (1910, pl. 16, fig. 48) figured a seed partially enclosed by a fruit 6 or 7 mm. long. Heer, moreover, stated that he had seen a drawing (natural size) by Pengelley, of a fruit which measured 13 mm. in length and 10 mm. in breadth. The drawing is reproduced by Heer (1862, pl. 60, fig. 50). Another fruit, recently examined by the author, enclosed an immature seed (Pl. 12, fig. 37) 1·75 mm. long and 1·5 mm. broad. The seed was obovoid with two irregular longitudinal crumples on the dorsal face, and with a sunk median area (chalaza ?) on the ventral face surrounded by a broad, marginal, horse-shoe shaped, inflated area over which the cells radiate from the centre. Cells from 0·025 to 0·03 mm. broad. No embryo-scar was seen.

Remarks and affinities. The evidence from all organs points to relationship with the group Calameae of the sub-section Lepidocaryinae, family Palmae.

The fruits although so small and probably immature suggest *Calamus* as do the pollen grains. Heer regarded the prickles as identical with organs from Laubach in the Wetterau which Unger (1860) described as *Palaeospathe daemonorops* on account of their resemblance to the spines on the spathes of living *Daemonorops*. Heer also identified them with similar organs from Salzhausen and Hessenbrücken described by Ludwig (1860 : 86, pl. 20, figs. 2, 3) as *Chamaerops teutonica*. *Palmacites*, however, is a form-genus containing different organs of palms which cannot yet be ranged in well-defined genera. In view of the relatively full information now available about the Bovey species it appears reasonable to place it in the palaeotropical genus *Calamus*. Whether it should be referred to Unger's species *Daemonorops* is open to question. But for the present it is retained in the species after Heer.

Calamus daemonorops (Unger) ?

(Pl. 12, figs. 43, 44)

An obovoid seed, evidently immature, with two irregular longitudinal folds on the dorsal side, and a narrow spathulate chalazal area on the ventral side, may possibly be an isolated seed of *Calamus*. It appears to be related to Palmae as evidenced by the general structure, possibly also by the presence close to the base

on the dorsal side of a small raised sub-circular scar, 0·3 by 0·2 mm. in diameter, which may mark the embryo. The walls are 0·05 mm. thick, coarsely columnar in section, the columns are about 0·016 mm. broad, but as the texture is very vitreous they may not show their true structure. The surface is irregularly rugose, but its cells are indistinct. Length of seed, 2·87 mm.; breadth, 1·6 mm.

Family ZINGIBERACEAE

Genus ***SPIREMATOSPERMUM*** Chandler

Spirematospermum wetzleri (Heer)

1862. *Gardenia wetzleri* Heer : Heer, p. 1069, pl. 69, figs. 1–6.
1925. *Spirematospermum wetzleri* (Heer) Chandler, p. 17, pl. 1, figs. 8*a–c* ; text-fig. 5.

The characteristic spirally striate seeds were described and figured by Heer from Bovey and referred by him to the genus *Gardenia* (Rubiaceae). More recent researches by Chandler (1925) on similar material from the Eocene of Hordle demonstrated that the true relationship lay with Zingiberaceae, a conclusion subsequently corroborated by Kirchheimer (1936*a* : 98 ; 1937*a* : 50 ; 1939*a* : 275). No further specimens have been found in the Bovey Basin since Heer's discovery. The species is also known from the Bembridge Beds (Reid & Chandler, 1926 : 84, pl. 5, figs. 6, 7).

DICOTYLEDONES

Family MYRICACEAE

Genus ***MYRICA*** Linnaeus

Myrica boveyana (Heer) pars

(Pl. 12, figs. 45–48)

1862. *Carpolithes boveyanus* Heer, p. 1077, pl. 70, ? figs. 7–14 (in part).

Under the name *Carpolithes boveyanus* Heer may have included several species or genera which in their highly compressed state are difficult to distinguish. All are black, more or less flattened (sometimes laterally or marginally, sometimes dorsi-ventrally). Heer's description and figures are inadequate although his figures 8 and 12 with " longitudinal furrow " suggest seeds of Zanthoxyleae showing the typical hilar scar. The sections in figures 9 and 13, possibly also in figures 10 and 14 suggest either *Myrica* or *Carpinus*, probably the former.

In his description Heer points out that they are of " two different dimensions ; some are 3 millims. long and 2½ millims. wide ; others are 4–4½ millims. long and 3½ millims. wide".

An examination of hundreds of these small carpels suggests that while many specimens cannot at present be sorted there is clear evidence in the material of two genera viz. *Myrica* and *Carpinus*.

Typical *Carpinus* shows the longitudinal fibre grooves of the persistent perianth. The fibres terminate against a large basal scar where the fruit was formerly attached to a wing-like bract. The surface of such specimens is usually smooth and shining.

Typical *Myrica* shows a more irregularly rugose dull surface with no clearly defined large basal scar. Between these two types are others variously distorted, which might belong to one or other. They cannot at present be separated with certainty. Some, indeed, may be seeds, not fruits, and belong to other genera or families not yet recognized.

The fruit of living *Myrica* is superior, the seed is erect and orthotropous, solitary. There is a conspicuous basal placenta scar on the locule, and chalaza scar on the seed. The form of the locule when the two valves have separated, as in germination, is similar to that of *Carpinus*, urceolate in outline, somewhat compressed at right angles to the plane of dehiscence, but the wide sutures are very flat and more close-textured in *Myrica* than in *Carpinus*. Unfortunately the fossil seeds, when preserved at all, are much crumpled and do not well display the chalaza although there are hints of its presence. The locule surface is usually much corroded so that the placentation is not clear while evidence of a superior fruit is lacking. The texture of the endocarp and the sutures nevertheless appear to point to *Myrica* in many instances.

There may be more than one species of *Myrica* at Bovey. Some of the endocarps, as Heer noted, appear so much smaller and more inflated than others. As there is no clear line of demarcation under the conditions of preservation, all are grouped for the present as *Myrica boveyana* (Heer). The relationship of these endocarps to *Myrica* was recognized by Kirchheimer (1938 : 327, footnote).

Diagnosis. Endocarp bisymmetric, sub-ovoid, usually somewhat compressed and angled in the plane of symmetry. Locule not emarginate at the base. Basal part of wall not thickened. Length about 3·5–4 mm.; breadth in plane of symmetry, 3–3·8 mm. Smaller specimens, length about 2·5 mm.; breadth in plane of symmetry, 2 mm.

Neotype. Valve from a broad fruit. Brit. Mus. (N. H.), No. V.33868.

Description. *Endocarp :* One-loculed, somewhat rugose externally, rounded to sub-ovoid but somewhat angled at the margins, bisymmetric, often but not invariably compressed at right angles to the plane of symmetry. Dehiscing in this plane into equal valves showing the sub-urceolate locule on the inner surface which is not emarginate at the base. Locule narrowing into an apical stylar canal. At the base the wall is pierced by a short straight vascular canal and is not here thickened. No clear evidence of the attachment of the seed is yet available. Sutures wide, flat, close-textured. Endocarp wall compact in structure, formed of hard parenchyma, cells small, more or less radially aligned on the sutures. Locule surface smooth (always much corroded), longitudinally striate due to finely toothed cells which are oblong at the extremities of the locule to which they converge, equiaxial over the middle. A second coat sometimes overlies the locule-lining (= testa ?) and shows larger equiaxial cells about 0·05 mm. in diameter. Length of typical fruit, 3·5–4 mm.; breadth in plane of symmetry, 3–3·8 mm. Small specimens, length, 2·5 mm.; breadth in plane of symmetry, 2 mm.

Remarks. It is impossible to say how many of the variously distorted fruits should be referred to this species. A laterally crushed example is shown in Pl. 12, fig. 46 which may belong, but distorted specimens of this type are most difficult to sort and determine.

The presence of *Myrica* is confirmed by Ross from pollen (p. 75). The Recent genus has a wide range in the northern Hemisphere. It also occurs in South Africa and the Andes. It is especially sub-tropical. It is also a widespread Tertiary genus. The smaller Bovey specimens resemble endocarps found in the London Clay of Nursling. The species appears to be distinct from the large much-inflated *Myrica suppani* Kirchheimer (1938 ; 1939) from the German Brown Coal (spherical endocarps 2·3–5 mm. long, locule cordate at the base, carpel wall basally thickened).

Family Betulaceae

Genus ***CORYLUS*** (Tourn.)

Corylus sp.

(Pl. 13, figs. 49–51)

Part of a male inflorescence with anthers (Pl. 13, figs. 49, 50) enclosing pollen examined and determined by Dr. J. B. Simpson. The pollen, which was flattened, contained no intine ; its condition made it clear that it was a true fossil, not Recent material accidentally introduced. The grains, like those of *Corylus*, show the typical thickening of the exine in the neighbourhood of the pores, and the zone of granules around each pore, the granules being longer and not so close-set as in other regions of the exine.

Various modern species of *Corylus* differ slightly from one another in the size and prominence of the zone of granules, but Dr. Simpson has not determined the nearest living species.

Genus ***CARPINUS*** Linnaeus

Carpinus boveyanus (Heer) pars

(Pl. 13, figs. 52–67)

1862. *Carpolithes boveyanus* Heer, p. 1077, pl. 70, figs. 7–14 (in part).

Diagnosis. Fruits sub-ovoid, 2·5–4 mm. long, 1·75–2·5 mm. broad. Sometimes twinned.

Neotype. A fruit showing fibres and scar of attachment. Brit. Mus. (H. N.), No. V.33870.

Description. *Fruit :* Attached to a bract rarely preserved and then only as a fragment at the base. Very variable in shape and size, enclosed by the abraded accrescent perianth rarely with remains of short superior perianth segments (Pl. 13, fig. 57). On the whole sub-ovoid, bisymmetric and slightly compressed. Scar of attachment to bract basal, large, sub-circular (Pl. 13, figs. 52–54). Surface in the

better-preserved specimens showing slender longitudinal vascular bundles which arise from the margin of the basal scar; the strands themselves are often abraded but their position may be indicated by furrows (Pl. 13, figs. 52, 54, 56). Surface smooth, formed of small, oblong, longitudinally aligned cells about 0·008 mm. in diameter.

A few specimens show two fruits grown together. If, as appears likely, they really belong to *Carpinus* they may be due to the rare development of two fruits in a bract, for two female flowers are present in the early stages in living *Carpinus*. I have not been able to find any living twinned fruits to bear out this suggestion. Twinned fossils are shown in Pl. 13, figs. 59–65).

Endocarp: One-loculed, agreeing with the fruit in shape, style terminal forming a mucro when well preserved, showing remains of two style bases. Dehiscence along a marginal suture in the plane of symmetry. Cavity not well seen.

Seed: When preserved much shrivelled, its placentation obscure.

Length of best preserved fruits, 2·5–4 mm.; breadth, 1·75–2·5 mm. Scar breadth, 0·9–1 mm.

Remarks and affinities. A few fruits among a mass of small, black, crushed fruits and seeds are attributable beyond doubt to *Carpinus*. Possibly some of these were included in Heer's *Carpolithes boveyanus* which certainly included specimens of *Myrica*. The presence of an undoubted accrescent superior perianth, and the basal scar of attachment to a bract make the relationship to *Carpinus* clear. It is unfortunate that there is no evidence so far of the pendulous anatropous seeds which together with perianth and scar serve to distinguish this species from *Myrica*.

The same or a closely allied species of *Carpinus* occurs in the Bournemouth Marine Beds, at Cliff End near Mudeford, and in the Lower Headon of Hordle.

Family Fagaceae

Genus *FAGUS* Linnaeus

Fagus minima n. sp.

(Pl. 13, figs. 68–70)

Diagnosis. Endocarp unusually small, 3·75–4·5 mm. long; lateral faces, 2·5 mm., 2·2 mm. and 1·1 mm. broad respectively.

Holotype. An endocarp. Brit. Mus. (N. H.), No. V.33886.

Description. *Endocarp:* Trigonous with three unequal flat or concave sides. Broadest outline semi-oval, style apiculate, base with scar of attachment, 1 mm. in diameter, reaching the margin of the narrow face but not continued on to it as in the case of the other two faces, thus showing it to be one of a pair of nuts which abutted along the narrow face; angles sharp but not flanged. Surface smooth, but cell walls raised so as to form minute, irregular, sinuous, longitudinal crumples 0·008 mm. apart, also having irregularly rounded dimples 0·012–0·019 mm. in diameter which are so crowded towards the apex as to produce a rough surface; they may represent hair-bases. Length of endocarp, 3·75 mm.; breadth of broadest side, 2·5 mm.;

maximum breadth of narrowest side, 1·1 mm. (? originally about 1·75 mm. now folded in); maximum breadth of medium side, 2·2 mm. Length of endocarp found by C. & E. M. Reid (see below), 4·5 mm.

Remarks and affinities. One endocarp. Two others were figured by C. & E. M. Reid from Bovey (1910, pl. 16, figs. 67, 68). The angled form, character of attachment scar and surface, position and character of style, all indicate relationship with *Fagus*. The small size distinguishes it from any living species seen. No other fossil species so small has been recognized. The compressed form consequent on the narrowness of one side, and the correspondingly narrow triangular scar which terminates at the margin of the narrow side suggest that the endocarp was developed in a laterally compressed cupule. *Fagus* leaves are of common occurrence in Cretaceous and Tertiary deposits. Leaves of *Fagus* and of *Nothofagus* (Bandulska, 1924) occur in the Bournemouth Freshwater Beds.

Family Ulmaceae

Section Celtidoideae

Genus ***ZELKOVA*** Spach.

Zelkova boveyana n. sp.

(Pl. 13, figs. 71–73)

Diagnosis. Endocarp much inflated. Maximum diameter, 1·5 mm.; maximum diameter in plane of symmetry, 0·9 mm.; maximum diameter at right angles to plane of symmetry, 1·25 mm.

Holotype. An endocarp. Brit. Mus. (N. H.), No. V.33887.

Description. *Endocarp:* Approximately bisymmetric about a plane through the attachment and style, marked by a conspicuous marginal ridge (Pl. 13, figs. 72 73); asymmetric in this plane of symmetry about a line between the attachment and style so that the outline is gibbous on one margin near the attachment, and on the other near the apex (Pl. 13, fig. 71). The endocarp is much inflated producing a rounded-quadrilateral outline at right angles to the plane of symmetry (Pl. 13, fig. 72). Attachment indicated by a small depression from which obscure ridges diverge, a few also diverge from the marginal ridge. Surface rough with indefinite depressions that give rise to an obscure network, wall formed of small equiaxial cells 0·012 mm. in diameter.

Maximum diameter, 1·5 mm.; maximum diameter in plane of symmetry, 0·9 mm.; maximum diameter at right angles to plane of symmetry, 1·25 mm.

Remarks and affinities. One endocarp. The form and structure so far as it has been seen, relate the fruit to *Zelkova*, a genus represented by about six living species in North Temperate regions.

All species seen are much larger than the fossil, but they vary much in size, so that the relationship in size between the fossil and *Z. keaki* (for example) is comparable with that between *Z. keaki* (3 mm. maximum diameter) and *Z. sinica* (7 mm.). Size alone could not therefore exclude the fossil from this genus. *Z. sinica* resembles

the fossil closely in form, but most living species are more markedly curved, and some are actually hooked in the stylar region. The apparent absence of superficial fibres in the fossil may be due to its worn condition. There appear to be no other grounds for excluding it from the genus *Zelkova*.

Family Moraceae

Section Moroideae

Genus ***MOROIDEA*** nov.

Diagnosis. Unidentified genera of the section Moroideae, family Moraceae.

Moroidea boveyana n. sp.

(Pl. 13, fig. 74)

Diagnosis. Fruit markedly asymmetric in plane of symmetry. Stylar projection narrow. Length incomplete; breadth in plane of symmetry, 1·5 mm.; thickness, 0·7 mm.

Holotype. A fruit, broken at the rounded base. Brit. Mus. (N. H.), No. V.33888.

Description. *Fruit:* Sub-circular in outline, somewhat flattened laterally but sub-cuneate in transverse section, the narrower edge crested along the whole length preserved, the opposite edge and base of the fruit rounded. Style prominent, terminal at the apex of the crested margin, closely adjacent to a sub-terminal curved projection which marks the point of entry of the funicle to the sub-apical placenta inside the rounded margin. Carpel wall 0·05–1 mm. thick, formed of a few layers of small cells aligned radially so as to give a columnar appearance in section, producing superficially a closely punctate surface with pits 0·012–0·016 mm. in diameter.

Length of fruit, incomplete; breadth, 1·5 mm.; thickness, 0·7 mm.

Remarks. One fruit, broken at the rounded base. The interior and structure of the seed have not been seen. A similar fruit was found at Hordle giving evidence of both internal structure and of seed structure. In the Hordle specimen the relation to Moraceae was clear, and the evidence indicated a connexion either with the section Moroideae or with Artocarpoideae, probably with the former.

The chief distinctions between the Bovey and Hordle fossils lie in the style which is a narrow projection in the Bovey fruit, and a broad flat one with a broad flat stylar canal in the fruit from Hordle, and in the greater symmetry of the Hordle fruit. Such differences are probably of specific value, but this conclusion can only be established when a greater range of living and fossil material is available for comparison. In the meantime the Bovey and Hordle fruits are treated as specifically distinct.

Family Nymphaeaceae

Genus ***BRASENIA*** Schreber

Brasenia ovula (Brongniart)

(Pl. 13, fig. 75)

1862. *Nymphaea doris* Heer, p. 1072, pl. 70, figs. 32–37.
1925. *Brasenia* sp. (*B. ovulum* Brongn. ?) Chandler, p. 23, pl. 3, figs. 7*a–d*.
1926. *Brasenia ovula* (Brongn.) : Reid & Chandler, p. 99, pl. 6, figs. 15–18.

Description. *Seed :* Obovoid, now much crumpled and distorted, having an aperture at one end, measuring 0·45 mm. in diameter, from which the embryotega has come away. Surface black, glistening, with longitudinal corrugations about 0·075 mm. in breadth at the middle of the seed. Surface cells, 0·05–0·075 mm. in diameter, with interlocking digitations, the length of individual digitations often more than one-third of the total diameter of a cell; surface of cells finely punctate.

Length of seed, 2·25 mm.; breadth, 1·5 mm.

Remarks. One seed from Heathfield. Heer recorded numerous seeds from Bovey under the name *Nymphaea doris*. His seeds were 2·5–3·5 mm. long and 2–3 mm. broad, the diameter being slightly increased no doubt by the flattening of the the seeds. The species ranges in the British Tertiary from Bournemouth Marine to Hamstead Beds.

Family Magnoliaceae

Genus ***MAGNOLIA*** Linnaeus

Magnolia boveyana n. sp.

(Pl. 13, figs. 76–80)

1910. *Magnolia attenuata* Weber : C. & E. M. Reid, p. 165, pl. 15, figs. 1, 2.

Diagnosis. Seeds longer than broad. Length 6–7 mm., breadth 2·75–4·5 mm.

Holotype. Brit. Mus. (N. H.), No. V.33890.

Description. *Seed :* Anatropous, ovate in outline, narrow, longer than broad, much compressed (compression doubtless emphasized by fossilization), gently convex, angled longitudinally on one face with a shallow longitudinal depression on the other (the raphe side). Chalaza terminal at the broad end, marked by a small plug or scar which is pierced at the centre. Surface marked by a fine " finger-print " pattern due to polygonal cells, 0·01 mm. in diameter, cells aligned in rows, the rows being grouped in clusters. Testa (represented only by the inner hard coat) 0·4 mm. thick at the middle of the seed, formed of equiaxial cells arranged radially in a columnar manner, the columns about 0·016 mm. broad. Tegmen thin, translucent, longitudinally striate, structure obscure.

Length of a seed, 6 mm.; breadth, 2·75 mm. Length of a second seed, 6 mm.; breadth, 4 mm. Length of a seed found by C. & E. M. Reid (1910 : 165), 7 mm.; breadth 4·5 mm.

Remarks and affinities. Six seeds and several fragments. They resemble *Magnolia* seeds of the American longer-than-broad type. The species is larger, more ovate in outline, and less triangular in transverse section than *M. angusta* from the London Clay (Reid & Chandler, 1933 : 177, pl. 5, figs. 6–8).

Comparable living species are *M. grandiflora* Linn., and *M. glauca* Linn., but the former is a large, and the latter is a smaller species. C. & E. M. Reid (1910 : 165) named these seeds *M. attenuata* Weber, identifying them with *Magnolia* seeds found abundantly in the Rhine lignite ; but they were careful to indicate that as the type of *M. attenuata* was a leaf, and as another *Magnolia* species also occurred in the same deposit, the connexion of the Rhineland seeds with the leaves was not conclusively established.

On this account Kirchheimer (1936*a* : 85–86) recently instituted a new specific name *M. sinuata* for a species from Salzhausen in which he included the relatively narrow seeds of *M. attenuata* Weber and a broader-seeded species *M. hoffmani* Ludwig on the grounds of histological identity. *M. sinuata*, although some of its forms resemble the Heathfield specimens, appears to exhibit much greater variation both of form and size. On the whole it is appreciably larger, the length of the seed, 6–10 mm.; breadth, 5–9 mm., whereas the maximum length of the Heathfield seeds is 7 mm.; maximum breadth, 4·5 mm. Hence a distinct specific name, *Magnolia boveyana*, has been given to the seeds from the Bovey basin.

Family Lauraceae

Genus *CINNAMOMUM* Blume

Cinnamomum is represented at Bovey, according to Heer, by three species, two based on leaves (*C. rossmassleri* and *C. lanceolatum*), the third on leaves and flowers (*C. scheuchzeri*). Probably some of the cupules and berries hereafter recorded may belong to *Cinnamomum*. At present, however, they are referred to the family Lauraceae only, the evidence being insufficient for definite determination.

C. rossmassleri Heer was represented by two leaf-fragments both with the apex missing. Hence Heer himself regarded the determination as doubtful. The species is therefore omitted in the list on p. 77 as the figures (Heer, 1862, pl. 67, figs. 17, 18) are inconclusive and not distinguishable with certainty from those of *C. scheuchzeri*.

C. scheuchzeri and *C. lanceolatum* are better represented, and there can be no reason to doubt the occurrence of the genus *Cinnamomum* in the Bovey Lake deposits. No new leaves of either species have been found and the genus is not therefore included in the plant list on p. 77.

various genera and species

(Pl. 14, figs. 81–91)

In addition to the genus *Cinnamomum*, the Lauraceae are represented by leaves referred to *Laurus primigenia* Unger and to *Daphnogene ungeri* (Heer, 1862 : 1064,

pl. 65, figs. 1, 2, 6). Neither of these determinations are wholly satisfactory. There are a number of cupules and berries also. These were never seen by Heer or their affinities were not recognized.

C. & E. M. Reid (1910, pl. 16, figs. 64–66) figured three small wrinkled cupules clearly belonging to Lauraceae. Similar specimens (all small) are common both at Bovey and Heathfield. They vary from about 1·75–3 mm. in diameter. Sometimes they are cup-like with simple margins, sometimes they are notched or divided above into sepals. In a few the small unripe berry still lies within the calyx. In all the skin is much wrinkled, shining, formed of very small cells which may produce a finely striate effect.

The flattened skins or epicarp of larger, detached, formerly ovoid berries are also common. The epicarp is leathery, shining, often yellowish-brown and semi-translucent, mainly formed of equiaxial cells which may vary considerably both in form and size ; they are often about 0·025 mm. in diameter.

In some specimens, overlying these cells at the apex is a thin layer of polygonal cells about 0·05 mm. long and 0·025 mm. broad. These diverge from the apical scar, but quickly die out and become obscure so that they cannot be traced a short distance below the apex. Remains of the mesocarp commonly adhere to the epicarp and in some specimens enclose numerous ovoid or globular yellow oily (?) bodies about 0·05 mm. in diameter. The largest berry seen is 6 mm. long (incomplete) by 5·25 mm. broad (breadth increased by flattening).

It is possible, but unlikely in view of the immature condition, that detailed comparative study of cuticle and mesocarp structure in living and fossil material might serve to distinguish some at least of the genera represented, but it would require very long research and an abundance of living material for comparison. The berries and cupules can therefore only be referred to the family Lauraceae without suggestions as to the generic relationship.

Family Capparidaceae

Genus *CAPPARIDISPERMUM* nov.

Diagnosis. A form-genus to embrace seeds of Capparidaceae of which the nearer relationship is unknown.

Capparidispermum boveyanum n. sp.

(Pl. 14, figs. 92–96)

Diagnosis. Seeds transversely oboval about 2–3 mm. in minimum and 2·75–3·75 mm. in maximum diameter. Contiguous walls of the curved limbs form a condyle, they appear to be fused for most of its length. Testa tubercled, the tubercles oriented parallel with the margin of the seed. Surface cells equiaxial.

Holotype. Brit. Mus. (N. H.), No. V.33904.

Description. *Seed :* Woody, transversely oboval in outline, almost flat, approximately bisymmetric, splitting for germination in the plane of symmetry.

Locule with curved unequal limbs separated by a narrow curved condyle, the micropylar limb longer and narrower than the other (Pl. 14, fig. 96). The sutures in the plane of dehiscence are smooth finished surfaces both along the margins of the seed and on the condyle. Marginal suture variable in breadth, 0·18 mm. broad at the distal end of the seed ; 0·4 mm. broad near the proximal end on the concave outer curve of the short limb. Hilar scar large, oval, marginal between the limbs, sometimes sunk in an emargination (Pl. 14, fig. 94). Micropyle small, terminal on the longer limb. The walls which form the condyle appear to be completely fused for the greater part of their length except at the hilar end where they enclose a shallow V-shaped cavity (Pl. 14, fig. 96), 0·8 mm. long, 0·3 mm. wide at the margin.

The condyle is sometimes indicated externally by an elongate prominence which is smoother than the rest of the surface (Pl. 14, fig. 92). Testa tubercled externally, the tubercles often elongate parallel with the margin of the seed ; breadth of bases of tubercles, 0·05–1·5 mm.; height, 0·025–0·05 mm., surface cells equiaxial about 0·025 mm. in diameter giving the margins of the tubercles a clawed or digitate appearance. Testa in section formed of equiaxial cells, 0·017 mm. in diameter. Lining cells of seed-cavity, 0·017 mm. in diameter, equiaxial, in rows transverse to the length of the cavity.

Dimensions of four seeds respectively : 2·75 by 2 mm., 3·75 by 3 mm., 3·5 by 2·25 mm., 3·5 by 2·25 mm. (the last represented by one valve only).

Remarks. Four seeds and two fragments. The curvature of the locule, marginal hilum between the limbs and the long narrow condyle indicate relationship with Capparidaceae.

No living genus seen combines the characters of form, size and ornamentation, hence the reference to a form-genus *Capparidispermum*. It is possible that the specimen shown in Pl. 14, fig. 95, represents a second species, it is larger, flatter, and the short limb has a more marked spiral incurve. In the absence of more evidence it is regarded as a slightly abnormal seed of the same species.

Family Hamamelidaceae

Genus ? sp.

(Pl. 14, figs. 97, 98)

Description. *Seed :* Sub-oboval in outline, rounded at the apex, slightly excavated at the base, laterally compressed (compression exagerrated by fossilization), with a large, bilobed, slightly concave hilar scar lying across the base having one lobe on each flat face ; the lobes are unequal in length and breadth but occupy about half the length of the seed. The arrangement of the other organs has not been seen. Surface much abraded, rough as preserved, the polygonal cells being about 0·03 mm. in diameter and somewhat sinuous. In a few places the testa has cracked transversely on drying owing to the transverse alignment of one or more of its layers. As seen in section near the apex it is 0·25 mm. thick but its cells cannot

here be distinguished although at one point there is a false appearance of curved columns, 0·016 mm. broad, the results of the fracture of tissue which has become vitrified in fossilization. Lining of seed-cavity formed of equiaxial cells 0·012–0·016 mm. in diameter.

Length of seed, 5·25 mm.; breadth, 3·25 mm.; thickness, 2 mm.

Remarks and affinities. One seed. The form and the large lobed hilar scar extending over the base and continued on each side, indicate a seed of Hamamelidaceae. Although many seeds in this family show similar hilar scars, no living genus seen has so large a scar as the fossil, while in many it is considerably smaller. In certain living genera there are two distinct scars one on each side near the base, but not united over it. *Sinowilsonia* (length of seed, 6·5 mm.; breadth, 4 mm.) has a similar scar occupying almost half the length of the seed. *Fortunearia*, with a scar extending about one-third of the length, has a much larger seed as have many species of *Hamamelis*. While the relationship of the fossil to the family Hamamelidaceae is certain, the evidence is insufficient to determine the generic position, but perhaps the closest living genus is *Sinowilsonia*.

It is interesting to note that Dr. J. B. Simpson (1936 : 99) records the occurrence of pollen belonging to *Bucklandia*, *Corylopsis*, *Fortunearia*, *Loropetalum*, *Dicoryphe* and *Distylium* in the Scottish Tertiary coals of Ardnamurchan and Mull.

Genus ? sp.

(Pl. 14, fig. 99)

Description. *Fruit :* Represented only by a fragment of septum and fibrous axis adhering to the seed near its apex.

Seed : Originally ovoid (much compressed in fossilization). Hilar scar sunk, long and narrow, lateral but continued across the base where it terminates without extending on to the opposite face. Testa black, shining, showing the cell-structure fairly clearly ; around the scar the cells are elongate, approximately parallel with its margin, but over most of the surface there are fine parallel striations diverging obliquely from the middle which appear to be a secondary consequence of compression.

Length of seed, 4·75 mm. ; maximum breadth, 2·5 mm. Length of scar on lateral face, 2 mm.; breadth, 0·3 mm.

Remarks and affinities. One seed from Heathfield. The form, hilar scar, and surface all indicate relationship with Hamamelidaceae. It has not been possible to relate it to a genus. In *Hamamelis* the hilar scar is shorter and the seed larger. In *Corylopsis*, which has a long, sunk scar, there is also a marked facetting on the opposite side. *Fothergilla* has a small, sunk scar and the walls of the surface cells are much thicker.

The second species here described is quite distinct from the first in which the hilar scar is large, broad and bilobed.

Family Rosaceae

Genus ***RUBUS*** Linnaeus

Rubus microspermus C. & E. M. Reid

(Pl. 14, figs. 100–109)

1910. *Rubus microspermus* C. & E. M. Reid, p. 169, pl. 15, figs. 13–17.

Description. *Endocarp:* Laterally compressed, semi-circular, semi-oval or sub-ovate in outline, ventral margin straight or almost straight, dorsal margin semi-circular or markedly convex, base rounded, margin rimmed all round. Surface reticulate with conspicuous pits, angular in outline, separated by thin, sharp, clearly defined ridges, occasionally the ridges are prolonged on to the margin. Carpel wall formed superficially of small equiaxial cells 0·01 mm. in diameter.

Length of endocarp, 1–2·5 mm. (commonly 2·25 mm.); breadth, 1–1·8 mm. (commonly 1·25 mm.).

Remarks and affinities. Endocarps of this species are common at Bovey and Heathfield. Their relationship to *Rubus* was discussed by C. & E. M. Reid (1910 : 169) but a larger range of material is here shown (Pl. 14, figs. 100–109) to demonstrate variation in size and form. Prickles of *Rubus* which were reasonably assumed to belong to the same plant were also described and figured by C. & E. M. Reid (1910 : 169, pl. 15, figs. 16, 17). The endocarps have been compared with *Rubus acutiformis* Chandler which occurs at Hordle, Cliff End, Sandbanks, Branksome Dene and Studland, but the two species are clearly distinguishable although both are of unusually small size. *Rubus acutiformis* is commonly more pointed and narrower at the apex, and is therefore more ovate in outline as a rule, while the ventral margin is not infrequently very slightly concave, the apex being curved somewhat towards the ventral side. The well-marked marginal flange is most conspicuously developed on the ventral margin.

Family Leguminosae

Genus ?

(Pl. 15, figs. 110–112)

Description. One perfect compressed seed, and fragments of three others must be referred to Leguminosae. The original shape was probably lensiform (but the seeds are now flat owing to compression), the marginal hilar scar (obscured by marginal cracking) must have been small. The surface is formed of inconspicuous concave equiaxial cells 0·02 mm. in diameter, the walls are 0·25 mm. thick as seen in one of the incomplete specimens, 0·45 mm. thick around the hilar aperture, the cells being arranged in a columnar manner, the radial columns about 0·012 mm. broad; a shallow pocket, presumably connected with the radicle, lies immediately beneath the hilum, it is delimited on the surface of the cavity by elongate cells. Lining of main seed-cavity of convex equiaxial cells 0·012 mm. in diameter. Diameter of the perfect seed, 3·5–3·75 mm.; other specimens larger but incomplete.

Family Rutaceae

Section Zanthoxyleae

Genus ***RUTASPERMUM*** nov.

Diagnosis. A form-genus to include seeds of Rutaceae of which the nearer relationship is unknown.

Rutaspermum exaratum (Heer)

1862. *Carpolithes exaratus* Heer, p. 1079, pl. 70, figs. 24–27.

The seed was described by Heer as 3·5 mm. long, 3·3 mm. broad; the figures showed it as sub-circular in outline, much inflated, with a long, narrowly-triangular, sunk hilar scar (the "umbilical fissure" of Heer). The surface was ornamented with nodular ridges aligned parallel with the rounded dorsal margin, much as in a species to be described from Sandbanks, and ornamented also with fine polygonal cells or pits (the "innumerable dots" of Heer); but the species is larger than the Sandbanks seeds. The characters are clearly those of Zanthoxyleae, of the type referred to the form-genus *Rutaspermum*. In the absence of actual specimens and of more accurate figures than the diagrammatic illustrations given by Heer, the species cannot be clearly defined. Available evidence, however, suggests that it is of a very distinctive type.

Family Sabiaceae

Genus ***MELIOSMA*** Blume

Meliosma reticulata (C. & E. M. Reid)

(Pl. 15, figs. 113–118)

1910. *Calvarinus reticulatus* C. & E. M. Reid, p. 169, pl. 15, figs. 18–20.

Diagnosis. Endocarp about 5–5·25 mm. long, 3·75–4 mm. in maximum transverse diameter. External surface with about eighteen to twenty raised ribs over the proximal half which branch and anastomose to form a sharp network over the distal half.

Neotype. A perfect but laterally compressed endocarp. Brit. Mus. (N. H.), No. V.33924.

Description. *Endocarp:* Woody, obovoid, slightly compressed laterally (compression increased by fossilization), the transverse diameters being in the proportion of 7 : 10; bisymmetric about a plane which passes through the attachment, funicular canal and a marked marginal angle; splitting in the plane of symmetry into two valves. Funicular canal oblique, about 1 mm. long, placenta basi-lateral or sub-basal. External surface ornamented with about eighteen to twenty raised ribs diverging from the attachment over the lower half of the fruit and uniting, branching, and anastomosing, to form a network over the upper half of the fruit. Surface formed of polygonal cells 0·01 mm. in diameter. Walls 1·25–1·5 mm. thick. Surface

of locule rough, cell-structure very obscure, but the centipede-type of cells with interlocking walls characteristic of *Meliosma* can be traced oriented parallel with the lateral ribs on one small fragment ; the length of individual cells is obscure, but near the base their width is about 0·037 mm.

Length of endocarp, 5·25 mm.; breadth, 4·25 mm. Length of a second endocarp, 5 mm.; breadth, 3·75 mm.

Remarks and affinities. Six endocarps or valves and a number of fragments. The form, surface ornamentation, structure, and short oblique funicular canal relate these fossils to *Meliosma*. So far as it has been possible to study the different living species, the Bovey fossils are unique in the number of their longitudinal ribs and the fineness and sharpness of the apical network, also in the narrow oboval form. In living species the three diameters (two transverse and one longitudinal) are usually approximately equal but occasionally the transverse diameters may be slightly longer or shorter than the longitudinal. The considerable differences in the diameters of the fossil which give rise to the elongate form and lateral compression have not, however, been seen in the living forms.

C. & E. M. Reid (1910) described the species under the generic name *Calvarinus*, and referred it to the family Boraginaceae. There were two specimens from Heathfield and one from Bovey. Reid and Chandler also obtained endocarps from both localities.

Family Vitaceae

There are several types of vine seeds at Bovey and Heathfield. Heer (1862 : 1070, pl. 69, figs. 25–29) distinguished two species which he named *Vitis britannica* and *V. hookeri*. The figures are poor and the descriptions inadequate but the outstanding features are clear.

C. & E. M. Reid (1910 : 165, pl. 15, figs. 3–6) distinguished three species, *V. hookeri* Heer, *V. teutonica* A. Br. and *V. ludwigi* A. Br. The greater number of specimens are now referred to *Parthenocissus britannica* (Heer). One imperfect seed appears to belong to *V. hookeri* Heer. The specific relationship is discussed in the following pages where the species are described.

Two new species have been added, *Parthenocissus boveyana* from Bovey, and *Vitis stipitata* from Heathfield.

Genus ***PARTHENOCISSUS*** Planchon

Parthenocissus britannica (Heer)

(Pl. 15, figs. 119–122)

1862. *Vitis britannica* Heer, p. 1071, pl. 69, figs. 25, 26.
1910. *Vitis ludwigi* A. Br. : C. & E. M. Reid, p. 166, pl. 15, fig. 6 (not fig. 4 as in text).
1910. *Vitis teutonica* A. Br. : C. & E. M. Reid, p. 166, pl. 15, figs. 4, 5 (not fig. 6 as in text).

Diagnosis. Seed pointed-obovate in outline, smooth dorsally, slightly emarginate at the apex, chalaza elongate-ovate, surface grooved between chalaza and base ; sharply angled ventrally with infolds occupying more than half the length, deep,

narrow, straight but diverging upwards. Length, 4·75 mm.; breadth, 2·25–2·8 mm.; thickness, 1·5–2 mm.

NEOTYPE. A typical seed. Brit. Mus. (N. H.), No. V.33927.

DESCRIPTION. *Seed:* Pointed-obovate in outline, slightly emarginate at the apex, pointed at the base, with smooth contours, ventral and dorsal faces meeting at an acute angle, ventral face sharply facetted so as to form a conspicuous raphe ridge extending almost the whole length of the seed, the facets being flat or concave and meeting approximately at a right angle ; at the apex the ridge gives place to the shallow channel which produces the slight apical emargination. Ventral infolds deep, narrow, straight, occupying more than half the length of the seed arising near the base, diverging upwards so that the raphe ridge is broader above than below. Dorsal face flat, slightly emarginate at the apex having a shallow groove along which the raphe passes into the narrow elongate-ovate chalaza which lies above the middle of the seed. From the chalaza a well-marked groove passes to the base. Testa formed of two coats, the outer thin, its irregular elongate polygonal cells about 0·02 mm. in shortest diameter producing transverse striations which diverge from the chalaza and ventral infolds to the margin. The inner coat is hard, averaging 0·1 mm. in thickness, formed of cells 0·016 mm. in diameter arranged in radial columns. These cells give a finely pitted surface to the coat.

Length of seed, 4·75 mm.; breadth, 2·25–2·8 mm.; thickness, 1·5–2 mm. (somewhat distorted).

REMARKS AND AFFINITIES. Ten seeds and several fragments from Bovey. The smooth seed with long divergent infolds suggests relationship with the living *Parthenocissus*. The same species was apparently described by C. & E. M. Reid (1910) under the name *Vitis teutonica* A. Br. They state that " Heer's type specimens of *V. britannica* appear to be nothing but badly compressed seeds of this vine [*V. teutonica*], though his figures are scarcely recognisable ". Their description is " ovate-acuminate, gradually narrowed into the beak, granulate all over, inner face with long shallow pits, outer convex longitudinally sulcate with a narrow pyriform chalaza, length 4 mm."

The identity of these specimens with *Vitis teutonica* A. Br. from the German lignite cannot now be maintained. *V. teutonica* was originally based on leaves, but as seeds were associated with them, Unger applied the name to the seeds also (Braun, 1845 : 172 ; Unger, 1860 : 23, pl. 9, figs. 1–8). Unfortunately neither Unger's figures or diagnosis really define the species. Later German workers have also referred a variety of seeds from the Brown Coal to *V. teutonica*. Thus Kräusel (1920, pl. 25, figs. 1, 2) illustrates seeds with short, wide, divergent lateral infolds, a marked apical groove on the ventral side, a short elongate-obovate chalaza and shallow furrow between the chalaza and base on the dorsal side (pl. 24, figs. 20–23). His seeds appear more inflated than the Bovey specimens, and are sometimes fluted. Kirchheimer (1934 : 35, pl. 9, figs. 3–6) describes and figures a somewhat fluted seed under the name *V. teutonica*. It has a relatively small oval chalaza and appears quite distinct from the Bovey seeds. Later Kirchheimer (1938, pl. 4, figs. 12–15 ; 1939, pl. 2, fig. 3) figures other seeds under this name. The first shows a small median oval chalaza and very wide sub-parallel ventral

infolds. The second shows a much larger chalaza which is elongate-oval in shape occupying the upper half of the seed, while wide and divergent ventral infolds and a markedly stipitate base arise out of the rounded, smooth, lower half of the seed.

The Bovey fossil appears to be sufficiently distinctive in its shape and chalazal character and in the narrow upwardly divergent infolds to merit a distinct specific name and *Parthenocissus britannica* (Heer) is here retained for this purpose.

Another Bovey seed described and figured by C. & E. M. Reid (1910 : 166, pl. 16, fig. 6) as *V. ludwigi* ? is also probably a differently distorted specimen of *P. britannica*, although in the description it is said to have a more slender form with an oval, not pyriform, chalaza. Such individual differences may, however, occur among living seeds within a species.

Parthenocissus boveyana n. sp.

(Pl. 15, figs. 123–125)

Diagnosis. Seed obovate in outline, not emarginate at the apex, contours smooth, chalaza median oval, angle of raphe ridge about 135°, ventral infolds markedly divergent upwards. Length, 3·5 mm.; breadth, 2·75 mm.; thickness, 1 mm.

Holotype. Brit. Mus. (N. H.), No. V.33929.

Description. *Seed :* Obovate in outline, not emarginate at the apex, pointed at the base, contours smooth, ventral face facetted, the facets being slightly concave and meeting at an angle of about 135° so that the raphe-ridge is not very sharp or conspicuous ; the raphe itself—a stout cord—is preserved above the middle on the ventral face and is continued on to the dorsal face passing into the external chalaza. Ventral infolds deep and narrow, extending from near the base to a quarter of the length from the apex, they diverge above and are slightly convex towards the raphe-ridge which is therefore triangular. Dorsal face almost flat, very slightly convex, not emarginate at the apex, or if it is grooved, the groove is obscured by the preservation of the raphe ; there is a shallow median groove between the chalaza and the base. Chalaza oval situated rather above the middle of the seed, gradually narrowing above into the raphe. Surface rather rough especially at the base and apex and on the chalaza, cells diverging from the lateral infolds and from the chalaza, many of them elongate in the direction of divergence, others polygonal 0·012 mm. in diameter. Wall as seen in section columnar, the columns about 0·012 mm. in diameter. Thickness of wall, 0·1 mm.

Length of seed, 3·5 mm.; breadth, 2·75 mm.; maximum thickness, 1 mm.

Remarks and affinities. One seed, and an imperfect specimen possibly referable to this species. The seed is relatively broader than seeds of *V. britannica*, and has a larger, broader chalaza, and more divergent lateral infolds. It is less rounded and stipitate than Kirchheimer's figures of *V. teutonica* (1939, pl. 2, figs. 3*a–e*) and lacks the emarginate apex. Its chalaza is much larger than that in Kirchheimer's figure (1938, pl. 4, fig. 14).

Genus ***VITIS*** Linnaeus

Vitis hookeri Heer

(Pl. 15, figs. 126, 127)

1862. *Vitis hookeri* Heer, p. 1070, pl. 69, figs. 27–29.
1910. *Vitis hookeri* Heer : C. & E. M. Reid, p. 165, pl. 15, fig. 3.

Description. *Seed :* Broadly obovate in outline but scarcely emarginate at the apex, pointed at the base, contours smooth and rounded. Ventral face facetted so as to form a conspicuous raphe-ridge, ventral infolds broad widening upwards, about half as long as the seed. Dorsal face rounded with slight flutings diverging from the ovate chalaza which is situated above the middle of the seed. Between chalaza and base is a deep median groove. Testa, 0·075 mm. thick, formed of cells 0·0125 mm. in diameter which have a columnar radial arrangement ; they give rise superficially to a finely and evenly but deeply punctate surface.

Length of seed, 3·75 mm.; estimated breadth (actually incomplete), 3·5 mm.

Remarks and affinities. One incomplete seed from Heathfield ; also a second from Bovey which may possibly be referred to this species. This second specimen is much distorted being compressed from base to apex, but its features can be seen and measured, and agree with those described above. It is slightly stipitate.

Except that the better preserved specimen is not stipitate, it shows characters which agree with those of *Vitis hookeri* Heer of which Heer found one seed at Bovey. There is general agreement in size with Heer's specimen (length, 3·5 mm; breadth, 3 mm.), the contours are in general similar to those in Heer's inadequate figure ; the chalaza is of comparable size and, although not round, occupies a very similar position on the dorsal surface when due allowance is made for its displacement by distortion which has brought it nearer to the apex than it originally lay. In the second much distorted specimen, the chalaza is round and but slightly above the middle. Comparison of the ventral face cannot be satisfactorily made both because of the distortion of the new material and because Heer's figure cannot really represent the ventral aspect of any vine. While, therefore, identity with Heer's species *V. hookeri* is not indisputably established, it seems probable that the new specimens should be referred to that species. The presence or absence of stipitation is not in itself of great importance, for Recent grape-seeds show that this character varies considerably in a single species. C. &. E. M. Reid (1910 : 165, pl. 15, fig. 3) described as *V. hookeri* Heer a seed which is probably correctly so named, although its chalaza is somewhat smaller than that shown in Heer's type. But variation in size of the chalaza also occurs in living species. The ventral side of this seed was not shown.

Family Tiliaceae

Genus ***TILIA*** Linnaeus

Tilia sp.

(Pl. 15, figs. 130–132)

Two groups of anthers were obtained from Heathfield and were sent to Dr. J. B. Simpson for examination. In a letter (27.iii.38) he reported that they yielded

typical pollen of *Tilia*, adding " I am not well acquainted with the pollen of many of the tropical genera of Tiliaceae, and so cannot positively exclude the other genera except *Grewia* and *Luhea*, but certainly they [the pollen grains] agree so perfectly with *Tilia*, that I feel sure it must be this genus they represent ". A further report after a greater variety of living material had been obtained and examined was expected but has not come to hand. But in a letter dated 1.iv.38 Dr. Simpson adds in writing of the fossil pollen " The furrows are short and deep and have the appearance of pits and occur in the middle of the sides not at the rounded corners of the triangular grain. The exine . . . is irregularly reticulate with a fine mesh ".

Ross, working quite independently of Simpson recorded " cf. *Tilia* " based on pollen.

Family Lythraceae

Genus ***MICRODIPTERA*** nov.

Diagnosis. Fruit many-seeded. Seeds anatropous, compressed at right angles to the germination valve and in the plane of symmetry. Valve an oval operculum as in *Diclidocarya menzeli* E. M. Reid in the lower part of the dorsal surface. Seed-body flanked by two thin lateral wings with spongy internal tissue. Wings more or less equally developed.

Type species. *Microdiptera major* n. sp. from the Eocene of Sandbanks (awaiting full description). Brit. Mus. (N. H.), No. V.34249.

Microdiptera parva n. sp.

(Pl. 15, figs. 133–149 ; Text-fig. 2)

Diagnosis. Lateral wings very thin, markedly concave on the ventral side, raphe straight and narrow, triangular form of seed rare. Maximum length of seed so far recorded, 1·25 mm.; maximum breadth, 1·75 mm. (2 mm. in Cliff End specimen).

Holotype. A seed. Brit. Mus. (N. H.), No. V.33934.

Description. *Seed :* Anatropous, much compressed dorsi-ventrally ; oboval, sub-circular, transversely oval, irregular in outline, or occasionally broadly triangular, differentiated into a median elongate-oval body and thin lateral wings, convex on the dorsal surface, concave on the ventral. Raphe prominent, linear, median longitudinal on the ventral face flanked by the marked concavities of the wings, hilum marginal. Germination by an oval operculum on the lower half of the dorsal face, associated with the basal micropyle. Internal chalaza circular at the apex of the seed (Text-fig. 2). Testa formed superficially of a shining, black coat giving a netted surface with large cells or pits equiaxial at the apex, more irregular and elongate below. Over the operculum the cells are very regular, equiaxial, about 0·05 mm. in diameter, arranged in about seven regular longitudinal rows. Some specimens show in addition evidence of small cells, 0·01–0·012 mm. in diameter, also aligned in longitudinal rows. Within the superficial coat and clearly seen on

abraded seeds is a layer of fine cells 0·012 mm. in diameter; they are arranged so as to give rise to striations which curve around the operculum, across on to the wings, and lie parallel with the margin of the wings near the circumference of the seed. Near the margin, the wings are only 0·025 mm. thick, but they thicken towards the seed-body close to which they measure 0·06 mm. in thickness. The external coats are close-textured and no cells can be distinguished in section ; near the body the dorsal coat is 0·025 mm. thick, the ventral 0·012 mm., the middle layer is 0·025 mm. thick and is much less compact than the outer layers, but its cell-structure cannot be clearly seen. The coat surrounding the seed-cavity is hard and compact, it is 0·05 mm. thick on the dorsal side, 0·037 mm. thick on the ventral side. The seed-cavity is finely striate longitudinally. The tegmen is semi-translucent and is fused with the testa at the large black chalazal scar.

FIG. 2. *Microdiptera parva* n. gen. et sp. Diagrammatic longitudinal section through seed-cavity. × 45 approx.

The dimensions of a series of seeds are as follows :

	Length (mm.)	Breadth (mm.)
(1)	1·25	1·75
(2)	1·0	1·25
(3)	1·0	1·5
(4)	1·0	1·75
(5)	1·25	1·0

Typical dimensions of germination opercula are respectively 0·5 by 0·3 mm., 0·5 by 0·4 mm., 0·6 by 0·4 mm., 0·5 by 0·4 mm., 0·55 by 0·35 mm., 0·4 by 0·3 mm.

REMARKS AND AFFINITIES. The characters are those of Lythraceae, more especially the position of the organs, the form of the anatropous seed and the structure and arrangement of the wings. The systematic position will be discussed in greater detail when the type species from Sandbanks is described in a forthcoming catalogue. At Bournemouth not only isolated seeds, but some still in the position of growth in a fragment of fruit were found.

Family Nyssaceae

Genus *NYSSA* Gronov.

The genus *Nyssa* from Bovey is in urgent need of revision. Four supposed species, truncate at one end, must now be referred to *Symplocos*. They are *Nyssa europaea* Unger (Heer, 1862 : 1066, pl. 69, figs. 11–17 ; C. & E. M. Reid, 1910 : 67, pl. 15, fig. 9), *Nyssa laevigata* Heer (1862 : 1066, pl. 69, fig. 18), *Nyssa microsperma* Heer (1862 : 1067, pl. 69, fig. 24 ; C. & E. M. Reid, 1910 : 167) and *Nyssa obovata* Weber (C. & E. M. Reid, 1910 : 168, pl. 15, fig. 10).

One specimen figured as *Nyssa ornithobroma* Unger by C. & E. M. Reid (1910 : 168, pl. 15, fig. 11) does not agree with Unger's species and may be a *Mastixia*.

Others are of uncertain relationship : *N. striolata* (Heer, 1862 : 1067, pl. 69, figs. 20–23). The figures show an ovoid ribbed fruit with finer, closer, more regular ribbing than that of *N. boveyana* (now to be described). Heer's fig. 23 shows a mass of fruits lacking both the finer ribbing seen in his figs. 20–22, and the coarser ribbing of *N. boveyana*. The types in the Geological Survey Museum were so decayed in 1910 that the true nature of this endocarp could not be discovered, all finer features being obliterated.

There remains in these earlier records *Nyssa vertumni* Unger (C. & E. M. Reid, 1910 : 168, pl. 15, fig. 12) which is undoubtedly *Nyssa*.

There is indeed abundant evidence of the genus which occurs both at Bovey and Heathfield but the evidence is of one species only, now described as *N. boveyana* n. sp.

Nyssa boveyana n. sp.

(Pl. 16, figs. 150–157)

Diagnosis. Endocarp sub-ovoid or less commonly sub-obovoid, tending to be arched, the dorsal side being less convex than the ventral, ventricose in the upper part of the ventral face. Germination valve triangular, relatively narrow in proportion to its length, 2·5–4·5 mm.; breadth, 2·5–3·25 mm. Length of endocarp, 6·8–11·5 mm.; breadth, 3·1–5·5 mm.

Holotype. Brit. Mus. (N. H.), No. V.33944.

Description. *Endocarp :* Sub-ovoid or less commonly sub-obovoid with a tendency to be less convex on the dorsal than on the ventral side, frequently ventricose in the upper part of the ventral surface, inflated and rather narrowed towards the base (but now usually flattened and often distorted in fossilization). The surface shows conspicuous, broad, rounded, longitudinal ribs and thin strands of fibres in the intervening narrow furrows ; the ribs, six to twelve in number, extend from base to apex on the ventral and lateral faces, are in general smoothly rounded but have a tendency to become nodular especially over the ventricosity, they are symmetrically

placed, four or five being ventral and two lateral ; along the crests of the lateral pair at the top of the endocarp are the sutures of the dorsal germination valve. Valve sub-triangular, gaping at the apex and along the sides which are slightly incurved towards the base, breaking irregularly along its base which is also that of the triangle.

On the dorsal surface there is a thin thread-like median rib, sometimes flanked on each side near the base by a broad scarcely raised rib, these die out before reaching the valve.

Length of endocarp, 6·8–11·5 mm.; breadth, 3·1–5·5 mm.

The dimensions of a series of endocarps, in millimetres, are as follows : 9·5 × 4·6, 10 × 4·6, 10 × 4, 9 × 5·1, 9 × 6, 11 × 3·1, 9 × 4·2, 11 × 4·2, 7·2 × 4·2, 9·8 × 4·5, 8 × 3·8, 9·8 × 5·5, 9 × 4, 10·5 × 4·8, 9 × 4·6, 7·4 × 4·9, 8 × 4, 7·2 × 4·1, 8 × 3·7, 9·5 × 5, 11·5 × 5, 6·8 × 8·9, 8·4 × 4.

Remarks and affinities. One of the most abundant fossils in the Bovey lignite basin occurring in profusion in the upper beds at Heathfield and in the lower beds at Bovey (C. & E. M. Reid, 1910 : 167). The structure of the endocarp and the characteristic short dorsal germination valve place them beyond doubt in *Nyssa*. Although now almost invariably flattened they were obviously much inflated in life. The many directions of distortion and compression show that originally they were but slightly compressed dorsi-ventrally below the valve. The valve itself was flat or slightly concave while there was considerable ventricosity in the corresponding part of the ventral face. Some specimens have been folded upon themselves from top to bottom, the folding always being towards the dorsal side. A few have been flattened laterally ; these show the difference in curvature of the two surfaces described. The position of crushing has affected the appearance of the ridges which may be almost obliterated or folded longitudinally so as to appear as sharp ridges.

The specific determination of fossil *Nyssa* presents great difficulties as was recognized by Kräusel (1920) and later, in a series of papers by Kirchheimer.

Initially Kirchheimer (1934) regarded the abundant Brown Coal species described by Kräusel (1920), Gothan & Sapper (1933) and himself as agreeing both in morphology and histology with the Recent *Nyssa sylvatica* Marsh and indistinguishable from it. In later reviews of the subject (1938, 1939) he included all the Brown Coal " species " (including Middle Oligocene to Pliocene forms) in a single " form-species ", *Nyssa disseminata* (Ludwig), on the grounds that the characters did not permit of true specific determination. The length of *N. disseminata* was given as 0·8–1·9 cm.; breadth as 0·5–1·2 cm. (1938 : 339) ; length, 1–2 cm.; breadth, 0·5–1·2 cm. (1939*a* : 270).

It has not been possible to make a study from actual Brown Coal material and it is abundantly clear that at present species cannot be distinguished on histological grounds. It may, however, be possible to separate some species at least by size and shape of the endocarp plus shape of the germination valve. Thus the Pliocene Reuverian endocarps recorded as *N. sylvatica* by C. & E. M. Reid (1915) are distinguishable on these grounds from the Bovey species although apparently agreeing closely with the living *N. sylvatica*.

	N. sylvatica (Recent)	*N. sylvatica* var. *biflora* (Recent)	*N. sylvatica* (Pliocene ; Reuver)	*N. disseminata* (Brown Coal)	*N. boveyana*
Number of specimens used	40	12	49	Kirchheimer's measurements (1938 ; 1939*a*)	42
Length of endocarp	6·9–8 mm.	7·5–10·5 mm.	5·5–11 mm.	8–20 mm.	6·8–11·5 mm.
Breadth of endocarp	4·5–6 mm.	5·2–7 mm.	3·5–6 mm.	5–12 mm.	3·1–5·5 mm.
Length of valve	3–3·5 mm. (5 specimens only)	3·5–3·6 mm. (2 specimens only)	2·25–3·25 mm. (8 specimens)	—	2·5–4·5 mm. (13 specimens)
Breadth of valve	4–5 mm.	4·5–5 mm.	3–4 mm.	—	2·5–3·25 mm.

The valve measured in Kirchheimer's figure of a Brown Coal *Nyssa* (Kirchheimer, 1938, pl. 4, fig. 24) appears to be : length about 4·5 mm.; breadth, 3·5 or 4 mm.

It will be noted that the Bovey endocarps are relatively longer, and narrower than those of *N. sylvatica* while the valves have a relatively narrow triangular form. These characters can be seen in the published figures.

It is possible, basing the suggestion on experience of the wide range shown by many other Eocene and Oligocene genera and species, that the Brown Coal species of *Nyssa*, at least in the older beds, may indeed be a true single species. Whether it should in that case be referred to *N. disseminata* Ludwig (1857) or to *N. rugosa* Weber (1852) is not within the scope of this paper. It does, however, raise the question of the relationship of the Bovey *Nyssa* to the Brown Coal forms, for it might be reasonably supposed that the same wide-ranging species occurred in Germany and Britain.

The figures already quoted, together with an examination of the published illustrations of *N. disseminata* (or *N. rugosa*) suggest that the Bovey *Nyssa* should provisionally be regarded as distinct. The germination valve in the two species is of similar narrow triangular character differing markedly from that of *N. sylvatica* from any source. On the other hand the Bovey *Nyssa* is appreciably smaller on the whole than the Brown Coal endocarps judging by Kirchheimer's measurements quoted above. Moreover if his figures (1938, pl. 4, figs. 21–24) are typical they show that *N. disseminata* tends to produce endocarps which are normally broadest above the middle : those from Bovey show a majority which are broadest at the middle. In view of these features a distinct name, *Nyssa boveyana*, has been given to the British material. But it obviously more closely resembles *N. disseminata* than *N. sylvatica* whether Recent or Pliocene.

Family Myrtaceae

Section Myrtinae

Genus ***MYRTOSPERMUM*** nov.

Diagnosis. Seeds referable to the family Myrtaceae and probably to the section Myrtinae, with curved or U-shaped cavities, marginal hilum at the end of a condyle

between the limbs of the curved cavity. Chalaza close to the hilum, terminal or sub-terminal on the inner side of one limb, micropyle adjacent to the hilum, terminal on the other limb.

Type Species. *Myrtospermum variabile* n. sp. Bournemouth Freshwater Beds (awaiting description). Brit. Mus. (N. H.), No. V.34248.

Myrtospermum boveyanum n. sp.

(Pl. 16, figs. 160–168)

1910. " compressed winged seed " C. & E. M. Reid, p. 173, pl. 16, figs. 61, 62.

Diagnosis. Seed of variable shape, much compressed, glossy, with thin testa. External surface ornamented with very regular concentric rows of cells 0·05–0·1 mm. in diameter (pits or convexities). Diameters of seeds, 1·25–2 mm.

Holotype. Brit. Mus. (N. H.), No. V.33950.

Description. *Seed:* Bisymmetric, flat (the degree of compression emphasized by fossilization, sometimes distorted and folded on itself), sub-oval, transversely-oval, sub-circular, or rounded-triangular, sometimes slightly emarginate at the hilum; limbs of the U-shaped cavity somewhat unequal in length and breadth, the micropylar limb being the longer and narrower. Hilar-scar elongate-oval, marginal between the limbs, micropyle small terminal on one limb, chalaza small sub-terminal on the other. Surface shining, ornamented externally with polygonal or hexagonal pits 0·05–0·1 mm. in diameter, but a few specimens give clear evidence that the pits are actually highly convex areas which have now collapsed; the pits are aligned parallel with the margin of the seed except near the middle where they diverge from the narrow median area between the limbs. In this median area individual pits are usually very obscure but when visible they are longer and narrower in this part of the testa than over the rest of the surface. In certain specimens the outlines of the surface pits are confused possibly owing to the presence of fine parenchymatous cells which form their walls as in other species of *Myrtospermum*. Testa only about 0·075 mm. thick in section. The outer part is formed by the coarsely pitted coat, the inner part shows evidence of equiaxial or rectangular cells 0·012–0·016 mm. in diameter; its structure is often obscure owing to intense compression. Diameter of seeds, 1·25–2 mm.

Remarks and affinities. Numerous seeds, all much crushed so that they are reluctant to split in the plane of symmetry. Fortunately one imperfect seed had split naturally and shows the U-shaped cavity and marginal germination. The form of the cavity was confirmed in other specimens by treatment with nitric acid, potassium chlorate and ammonia which rendered them semi-translucent. The curved form and unequal limbs are also clearly indicated by the alignment of the surface sculpture. The species occurs both at Bovey and Heathfield.

The relationship of the fossil to Myrtaceae is fully discussed in a forthcoming catalogue on the Bournemouth flora.

The species here described as *M. boveyanum* differs from others from Bovey, Heathfield, the Bournemouth Beds and elsewhere in its extreme degree of compression

which must be, in part at least, original. It differs also in its thin walls, glossy surface and in the extreme regularity of its surface sculpture. It is also larger than the common Tertiary species awaiting description in a forthcoming catalogue as *Myrtospermum variabile*. Two specimens were figured and described by C. & E. M. Reid (1910 : 173, pl. 16, figs. 61, 62) but not named.

Myrtospermum dubium n. sp.

(Pl. 16, figs. 169–172)

Diagnosis. Seed sub-circular or irregular in outline. Surface pits 0·025–0·05 mm. in diameter near the circumference, smaller near the hilum and between the limbs. Diameter of seed, 1·25–2 mm.

Holotype. Brit. Mus. (N. H.), No. V.33957.

Description. *Seed :* Sub-circular or irregular in outline, somewhat inflated, approximately bisymmetric but with a tendency to be more convex on one side than on the other. Two specimens have a slight elevation over the condylar area between the limbs of the U-shaped seed-cavity ; the exact form of the cavity is not exposed. Marginal hilum large, oval, micropyle small. Surface pitted, pits polygonal or hexagonal, about 0·025–0·05 mm. in diameter near the circumference, smaller and more obscure towards the hilum and between the limbs, tending to be arranged in rows parallel with the margin and to diverge from the area between the limbs. Tegmen thin and translucent, cells not seen.

Diameter of four seeds respectively, 1·6 mm., 1·6 by 1·25 mm., 2 mm., 1·75 by 1·25 mm.

Remarks. Five seeds all much compressed and carbonized. One was fractured transversely whereupon it showed the two limbs of the cavity in transverse section; owing to the mode of preservation, the structure of the wall is obscure. The diameter is twice as great as that of typical seeds of *M. variabile*.

Myrtospermum sp.

(Pl. 16, figs. 173, 174)

Description. *Seed :* Bisymmetric, broadly sub-oval in outline, slightly truncate at the hilar end, inflated, but having a somewhat depressed median area; U-shaped cavity with a maximum diameter of 0·35 mm.; micropylar limb longer and narrower than the chalazal limb, micropyle terminal at the end of the longer limb, chalaza sub-terminal on the other. Surface deeply pitted, pits equiaxial and hexagonal near the margin where they are 0·07 mm. in diameter, becoming irregular in form and size away from the margin, narrow and elongate over the condylar area between the limbs where they may measure 0·1 by 0·03 mm. Their walls appear not to be built of small cells. They form thick ridges with a median groove along which there is a marked tendency for splitting to occur. Testa thick, maximum thickness at the end opposite to the hilum (0·12 mm.). The outer part of the testa as seen in section is a single coat of large simple prismatic cells with their longest axes (0·09 mm.)

at right angles to the surface. The collapsed outer ends of these cells form the surface pits. Inner part of testa formed of uniform parenchyma, the cells being 0·025 mm. in diameter and radially arranged.

Diameter of seed, 1·1 by 0·9 mm.

Remarks. One seed (V.33960), now broken at the hilar end and split marginally (irregularly) so as to expose the internal structure.

It differs in its small size from *M. boveyanum* and *M. dubium*. From *M. boveyanum* it also differs in its inflated form and less regular pitting. From *M. dubium* it also differs in its surface sculpture.

The single layer of prismatic cells forming the outer coat of the testa is characteristic. There is no indication, as in *M. variabile* from Cliff End, Sandbanks, Woolwich and Reading Beds, that it was formed of fine parenchyma. The middle lamella between the prismatic cells is clearly indicated by the narrow grooves along the middle of the ridges between the pits.

Family Cornaceae

Section Mastixiodeae

Genus ***MASTIXIA*** Blume

Mastixia boveyana n. sp.

(Pl. 17, figs. 175–178)

1910. *Mastixia* n. sp. C. & E. M.Reid, p. 166, pl. 16, figs. 73, 74.

Diagnosis. Endocarp with smoothly rounded, interrupted, longitudinal external ribs; median infold broad, rounded; wall with an external coat of parenchyma. Length about 11 mm. (estimated).

Holotype. A broken endocarp showing the infold. Brit Mus. (N. H.), No. V.33961.

Description. *Endocarp:* One-loculed, ribbed longitudinally, the ribs (about nine at each end, the number in the middle doubtful) smoothly rounded, interrupted, and with additional intercalated short ribs like elongate nodulations towards the middle of the endocarp. A large longitudinal germination valve occupies nearly half the breadth of the nut bearing on its inner surface a broad, rounded, median, longitudinal infold (0·4 mm. across, 0·8 mm. deep in the one specimen in which it could be measured); the length of the valve cannot be determined from the imperfect material available. Endocarp wall hard and woody, variable in thickness from about 0·4 mm. as measured through the grooves, to 0·5 mm. through the ribs, the locule being smooth, not ribbed in agreement with the external surface of the endocarp. In section the walls show the following structure: An inner coat of horizontally aligned sclerenchyma many layers thick giving a transversely striate locule-surface; the cells forming the outer layers of this coat gradually pass from a horizontal to an oblique, and from an oblique to a radial alignment, the radially aligned portion forming the main thickness of the wall. Along the margins of the valve, however,

the oblique alignment is never lost but passes across the walls to the periphery constituting planes of weakness along which the valve separates ; outside the radial cells are a few peripheral layers of parenchyma, superficially the cells which form the layers are irregularly polygonal with an average diameter of about 0·025 mm., and no definite alignment. These cells give a smooth surface to the endocarp.

Length of endocarp unknown, estimated to be about 11 mm.; diameter of one fragment (probably basal end), 2·7 mm. (possibly increased by distortion).

Seed : Not seen ; cells of the testa, 0·03–0·05 mm. in diameter, preserved as impressions on the locule wall superposed on the transverse striations of the locule-lining.

Remarks and affinities. Two fragments of *Mastixia* endocarp were figured and briefly described by C. &. E. M. Reid (1910 : 166, pl. 16, figs. 73, 74) but no attempt was made at specific diagnosis. Six more fragments have now been recognized in their collection, two are the ends of nuts showing the complete circumference, both being distorted obliquely. Another fragment is from the middle of a nut with both ends and the valve missing ; a fourth, incomplete at the ends, appears to have broken along the edge of the valve. It suggests a length of about 11 mm. for the perfect specimen. All fragments are recognizable by their ribbing and microscopic structure, they therefore appear to offer a sufficient basis for specific determination.

Detailed histological studies of *Mastixia* and allied fossil genera from the Brown Coal of Germany have been published by Kirchheimer in papers from 1934 to 1939. Many details of the sclerenchyma and parenchyma of the endocarps are shown. The genus *Mastixia* was first recognized as a fossil by C. & E. M. Reid (1910). It has also been recorded more recently from the London Clay (Reid & Chandler, 1933 : 448, pl. 25, figs. 1–17).

Family Primulaceae

Section Lysimachinae

Genus ***LYSIMACHIA*** (Tourn.)

Lysimachia boveyana n. sp.

(Pl. 17, figs. 179, 180)

Diagnosis. Seeds as in *Lysimachia*, 0·8–0·85 mm. long, 0·62–0·7 mm. broad. Surface rugosities forming small areoles with nodular boundaries. There are also semi-translucent tubercles especially well seen around the margin.

Holotype. Brit. Mus. (N. H.), No. V.33964.

Description. *Seed :* Rounded triangular in outline, originally gently convex on the dorsal face, facetted on the ventral face the two facets meeting to form a longitudinal median angle extending from margin to margin. Hilum elongate about the middle of this angle. Surface rugose, rugosities forming small areoles with nodular boundaries about 0·032 mm. in diameter on the ventral side, and 0·032 mm. or larger in diameter on the dorsal side. On the ventral side they are aligned

in rows directed from the median angle to the margin, on the dorsal side no such definite arrangement is apparent. Around the margin semi-translucent tubercles, 0·025 mm. long and 0·022 mm. broad, are visible. Similar tubercles, or their remains can also be seen over parts of the surface but they are less prominent than around the margin.

Length of seed, 0·8–0·85 mm.; breadth, 0·62–0·7 mm.

Remarks and affinities. Two seeds. The form, character of testa, and median hilum as described, are only to be found combined in the family Primulaceae. Seeds of this shape with a simple hilar ridge extending from edge to edge have been seen only in the Lysimachinae and closely comparable structure in the genus *Lysimachia*.

The majority of species have larger seeds, but in *L. japonica* some seeds are comparable in size (0·85 by 0·65 mm. and 0·9 by 0·65 mm. for example) although average sized seeds are larger (1·05 by 0·9 mm and 0·9 by 0·75 mm.).

The genus *Lysimachia* is distributed through the temperate and sub-tropical regions of the whole world.

Family Symplocaceae

Genus ***SYMPLOCOS*** Jacquin

Symplocos anglica n. sp.

(Pl. 17, figs. 181–186)

1862. *Nyssa europaea* Unger : Heer, p. 1066, pl. 69, figs. 11–17.
1910. *Nyssa europaea* Unger : C. & E. M. Reid, p. 167, pl. 15, fig. 9.

Diagnosis. Endocarp ovoid to obovoid or oblong, three-loculed, apical depression with gently sloping edges markedly truncating the apex of the endocarp. Base rounded. Outer surface finely wrinkled longitudinally. Length, 3·5–6·7 mm.; breadth, 2·2–4·4 mm.

Holotype. A somewhat compressed endocarp. Brit. Mus. (N. H.), No. V.33965.

Description. *Endocarp :* Syncarpous, three-loculed, locules arranged around a central canal, one or two occasionally being abortive, opening by wide apertures into the large apical depression the edge of which slopes gently inward being neither thickened nor rounded. At the rounded base is a small attachment scar from which the funicle passes into the central canal. The endocarp may be either obovoid, oblong with rounded base, or ovoid, markedly truncated at the top by the apical depression, but the truncation may be obscured either by the persistent base of the style or by oblique distortion when it appears ovoid. Wall possibly formed of fused mesocarp or endocarp (the former preserved only in part if present), or the mesocarp may be entirely absent ; thickness of wall averaging about 0·25 mm.; its outer surface is finely wrinkled longitudinally, it usually shows about twelve to

sixteen irregular, sometimes interrupted and nodular rather obscure longitudinal ribs ; surface cells mostly very small with obscure outlines but occasionally (when the mesocarp is abraded ?) the wall is finely and evenly pitted.

Length of endocarp, 3·5–6·7 mm.; breadth, 2·2–4·4 mm. Average length, 4·8 mm.; average breadth, 3·3 mm.; average breadth if uncompressed, about 2·1 mm.; breadth of apical depression as compressed, 1·5–2 mm.

Remarks and affinities. About thirty-four specimens, all much crushed, some symmetrically others obliquely. The species was described and figured as *Nyssa* both by Heer and by C. & E. M. Reid. However it is clear that such truncated specimens could not be *Nyssa* whereas they agree in character and size with the species of *Symplocos* here described. Other fossil species based on fruits are commonly much larger and differ in other ways. *S. gregaria* Unger (1866 : 31, pl. 11, figs. 1*g–h*) is one of the more comparable species but is more variable in size ranging from 4·1–12·5 mm. in length, and from 2·1–6·2 mm. in breadth (Kirchheimer, 1936*a* : 95, pl. 9, figs. 5*a*, *b*) gives the dimensions as 4–10 mm. length, 2·5–6 mm. breadth. The fruits of *S. gregaria* are represented as larger, more markedly truncate, with finer, more regular and numerous grooves and with thicker walls. *S. kirstei* Kirchheimer (1939 : 285, pl. 3, fig. 3) is also similar but larger (length, 5·5–11 mm.; breadth, 3·5–6 mm.) and relatively longer and narrower.

A new name, *Symplocos anglica*, has therefore been given to the Bovey fruits.

Symplocos headonensis Chandler

(Pl. 17, figs. 187, 188)

1910. ? *Nyssa obovata* Weber : C. & E. M. Reid, p. 168, pl. 15, fig. 10.
1926. *Symplocos headonensis* Chandler, p. 40, pl. 7, fig. 3 ; text-fig. 24.

Description. *Endocarp :* Syncarpous, four-loculed, the locules arranged around a central canal and opening above by wide apertures into a large apical depression ; broadly ovoid, urceolate, or sub-globular, conspicuously truncated by the apical depression ; margin of the apical depression thickened, somewhat rounded ; attachment indicated by a small sunk scar at the base, thickness of wall, 0·2 mm.; thickness of septum, 0·05 mm. Surface without ribs, but uneven, surface cells angular, unequal in size, with a tendency to be aligned in longitudinal rows near the base thus producing obscure fine striations.

Length of an obscurely four-lobed and slightly urceolate specimen (possibly immature), 6 mm.; breadth, 5·5 mm. Length of a second well-developed specimen, 7 mm.; breadth, 5·5 mm. Estimated diameter when uncompressed, 3·5 or 3·6 mm.

Remarks and affinities. Three specimens one of which is in the Geological Survey Museum if the specimen figured by C. & E. M. Reid (1910, pl. 15, fig. 10) really is of this character. The illustration indicates a larger, broader form than *S. anglica*. This species is near in size, form, and general appearance to *S. headonensis* Chandler from Hordle which see for the probable relationship of this species to living forms. The species occurs both at Bovey and Heathfield.

Family Solanaceae

Genus ***SOLANISPERMUM*** nov.

Diagnosis. Seeds of unknown generic relationship agreeing with Solanaceae in form and structure.

Solanispermum reniformis n. sp.

(Pl. 17, figs. 189–191)

1910. *Carpolithus* sp. 5 C. & E. M. Reid, p. 174, pl. 16, fig. 72.

A number of seeds of Solanaceae with distinctive rugose surface which characteristically weathers into fibres occur in the Lower Bagshot, Bournemouth Freshwater and Marine Beds, and the Cliff End Beds near Mudeford as well as at Bovey. The most perfect specimen was found at Branksome Dene and an extremely good seed showing the hilar aperture was found at Sandbanks.

In order that the description should be as complete as possible it has been largely based on material from the Bournemouth area.

Diagnosis. Seed transversely oval or reniform in outline, occasionally hooked, surface normally with coarse, interrupted, sinuous rugosities or tubercles which produce a pitted effect in places. An outer coat, rarely preserved, shows " pits " with sinuous outlines. The rugose coat shows fine striae at right angles to the tubercles. Splitting along the striae on drying produces a fibrous effect. Inner coat spongy formed of equiaxial cells. Maximum diameter of seeds about 3·5–4·8 mm.

Holotype. A perfect seed figured by C. & E. M. Reid (1910, pl. 16, fig. 72). Geol. Surv. Colln. No. 1805.

Description. *Seed:* Bisymmetric, flattened or slightly inflated, transversely oval or reniform in outline, occasionally hooked. Hilum usually marginal occupying part of the concave margin in reniform seeds and one of the longer margins in oval seeds, large and gaping, elongate-oval leading into a small cavity separated from the main seed-cavity by a thin curved partition seen in longitudinal sections of the seed. Probably the funicle lay close to this partition within the hilar cavity. A few seeds are distorted (in growth) so that a gaping hilum is twisted on to one of the broad surfaces. Dorsi-ventral flattening of such distorted seeds may have occurred. Micropyle usually marginal, adjacent to the hilum. Its position is most apparent in hooked seeds where it occupies the extremity of the hook. Surface occasionally showing traces of an outer coat with coarse digitate cells, but in most specimens this is worn away. As normally preserved ornamented with interrupted sinuous rugosities which diverge from the hilum. They produce a pitted effect in places, the pits being about 0·05–0·1 mm. in diameter. The rugose seed-coat is about 0·1 mm. thick; it appears striate, the striae crossing the rugosities more or less at right angles and lying parallel with the margin near the circumference of the seed. Splitting tends to occur along the striae in weathered or dried specimens producing

a fibrous effect. Close examination of the " fibres " shows them to be formed of fine equiaxial cells 0·012 mm. in diameter. Several layers of such " fibres " occur in this integument. Within it is a spongy coat, 0·4 mm. thick, formed of compact soft parenchyma. The lining of the seed-cavity is striate, the striae diverging from the neighbourhood of the hilum (actually from the closely associated chalaza).

Maximum diameter of seeds, 4·8 mm.; commonly 3·5 mm.; diameter at right angles to it, 2·25–3·6 mm.

Remarks and affinities. One seed figured by C. & E. M. Reid (1910) from Heathfield and another (now broken) from the same pit collected by E. M. Reid and Chandler in 1932. The curved outline, flattened seed, large gaping marginal hilar cavity and even the mode of distortion which brings the gaping hilar cavity on to one of the broad surfaces all suggest Solanaceae. Seeds of *Capsicum* and allied genera show a general resemblance but the succession of coats cannot be matched exactly in any genus examined. Striate fibrous coats, or striate fibrous outgrowths of the testa are found in *Lycopersicum* and *Cyphomandra*.

Reference to a living genus cannot be made and even the reference to the family is somewhat tentative until living seeds with a closely comparable succession of coats have been found. Meanwhile these readily recognizable specimens are referred to a new genus *Solanispermum* as it is in Solanaceae that the closest resemblance has so far been traced.

Incertae Sedis

Carpolithus sp.

(Pl. 17, figs. 192–194)

Fruit: Inferior with remains of three small triangular patent perianth segments at the apex. Elongate having three broad surfaces two of which are ventri-lateral and one dorsal. Surfaces separated by longitudinal angles, the lateral angles sharp and almost flanged, the ventral one fibrous. The broad perianth segments each lie opposite one of the broad surfaces. In profile the fruit is long and narrow. The ventral angle is straight. The dorsi-lateral angles are convex hence the two ventri-lateral surfaces are more or less semi-oval (but unequal). The dorsal face is narrowly oval. Ventral surfaces smooth formed of fine, close, elongate, obliquely aligned fibres, 0·008 mm. broad. Dorsal surface with similar fibres transversely aligned. Fibrous surfaces often concealed by a rough coat of equiaxial cells, 0·025 mm. in diameter.

Length, 2·25–3·5 mm.; breadth, 1–1·3 mm. Breadth of ventral faces in one specimen, 1 and 0·3 mm. respectively, and in a second specimen, 0·5 and 0·52 mm. respectively.

Remarks. Thirteen endocarps from Heathfield. The relationship of these small fruits has not been established. The difference in form of the dorsal and two ventral faces or facets suggests that the fruits grew in close association with one another, the ventral faces possibly in actual contact.

Carpolithus sp.

(Pl. 17, figs. 195–197)

A three-, four- or possibly five-partite capsule, the segments united still at the base. Segments lanceolate, three only preserved, two being attached, the third represented by a detached distal end. They diverge from one another and have strongly incurved tips. The length of one segment, 4·2 mm.; breadth, 0·9 mm. (but the full length is not shown owing to the strong incurving of the tip). The second (attached) segment 3·6 mm. with deeply incurved tip by 1·5 mm. The number of segments in the perfect fruit can only be guessed by the angle between existing segments.

Segments highly rugose and even nodular on both surfaces; margins greatly thickened and almost revolute. Hence the segments are concave externally, the broader one having a slight median ridge which makes it biconcave. All show traces of spines near the base, one each side of the median line in the shorter of the two attached segments. Cells of outer surface equiaxial, about 0·016 mm. in diameter.

Carpolithus sp.

(Pl. 17, figs. 198, 199)

Endocarp (?) *:* Syncarpous, sub-ovoid, three-lobed and three-carpelled, or two-lobed and two-carpelled by suppression, the base being sunk between the lobes. Dehiscing loculicidally from the apex (which is always broken irregularly), almost to the base. No central axis seen. Wall close-textured, hard, 0·033 mm. thick (cells indistinct owing to intensely carbonized condition in section). Surface smooth, of equiaxial cells 0·016 mm. in diameter usually evenly distributed but occasionally aligned in obscure longitudinal rows. Septa very thin, columnar in section. Locule lined by equiaxial cells, 0·012 mm. in diameter.

Length of longest specimen, 5·5 mm. (incomplete at apex); breadth, 3·25 mm. Length of second specimen, 4 mm.; breadth, 2·1 mm.

Seed (lying within the locule near the broken apex) : Linear with a median ridge on the concave side at one end, somewhat tufted at the other end, too decayed to show cell-structure. Length, 2·7 mm.; breadth, 0·6 mm. at the broadest estimate, but actually bent so as to appear only 0·5 mm. broad.

Remarks. Two specimens from Bovey, one from Heathfield. Also three very imperfect specimens from Bovey which may belong to this species. The relationship is undiscovered.

Carpolithus sp.

(Pl. 17, figs. 200–202)

Several much collapsed and immature fruits are narrow-obovoid or urceolate, three-lobed, three-loculed, the lobes being rather slender and much smaller than those figured in Pl. 17, figs. 198, 199. Base sunk between the lobes. Apex in best

preserved specimens with three minute patent persistent perianth segments one corresponding to each lobe. Dehiscence by loculicidal splitting from the apex downwards showing apical canals (or canal) (style ?). Surface dull, finely rugose, cells aligned in obscure longitudinal rows. Locule transversely striate, striae 0·0125–0·017 mm. apart due to small cells aligned in transverse rows. Thickness of walls about 0·025 mm.; thickness of septum (where seen near the apex), 0·016 mm. Length and breadth of four specimens respectively: 4·6 mm. (broken at one end) × 2·4 mm., 4·2 mm. × 2 mm., 4·2 × 2 mm., 4·6 mm. × 2 mm.

Seed: Occupying the whole length of the locule, flattened. Longitudinally striate.

Remarks. The form of this tiny fruit and the three minute patent perianth segments recall the rather larger, flattened, immature fruits of *Eomastixia bilocularis* found in the Bournemouth Beds and the considerably larger immature specimens of another *Eomastixia* from Lake (awaiting description). There is nothing in the limited evidence available to exclude such a relationship although it should be noted that living *Mastixia* perianth segments are four- to five-partite. A species of *Mastixia* occurs in the Bovey lignites but any suggestion as to the relationship must be regarded as tentative only.

Carpolithus sp.

(Pl. 17, fig. 203)

An elongate ovoid seed with a few longitudinal angles or crumples. No definite organs are visible but the alignment of cells at the pointed end and crumples at the broad end suggest the presence of organs in these positions. Surface formed of inflated longitudinally aligned cells about 0·025 mm. long and 0·001 mm. broad, but over much of the surface the cells have been abraded so that no cell-structure can be seen.

Length of seed, 2·6 mm.; breadth, 0·9 mm.

Bulbil ?

(Pl. 17, fig. 204; Text-fig. 3)

Two sub-spherical bodies, slightly flattened on one side with a large deep depression at the middle of the flat surface, and a second similar depression on one side, may

Fig. 3. Bulbil ? Diagrammatic section showing overlapping layers of thick bracts. × 4 approx.

be bulbils or buds. They show superficially an obscure network of shallow furrows. When fractured they reveal overlapping layers of thick bracts. Diameter about 6·6–7 mm. Relationship not known.

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Osmunda lignitum (Giebel)

FIG. 1. Two sporangia which have burst and become interlocked. × 28. (V.33833.)
FIG. 2. Diagram to explain Fig. 1. Annulus at (*a*).
FIG. 3. The same pair of sporangia, opposite surface. × 28.
FIG. 4. Diagram to explain Fig. 3. Annulus at (*a*).
FIG. 5. A single burst sporangium showing the annulus at (*a*). × 60 approx. (V.33833.)
FIG. 6. A group of spores embedded in remains of sporangium from the specimen in Figs. 1, 3. The spores show the fine granulations of the surface. × 400. (V. 33833*a*.)

All the above are from Bovey.

Salvinia boveyana n. sp.

FIG. 7. A sporocarp showing the globular thin-walled sporangia projecting through the wall. × 28. (V.33834.)
FIG. 8. Another less mature specimen showing a closely compacted mass of sporangia. Also figured C. & E. M. Reid, 1910, pl. 16, fig. 57. × 12. Geol. Surv. Mus. Colln. No. 76682.
FIG. 9. A sporangium showing spores embedded in a froth-like mass. × 150. (V.33835.)
FIG. 10. Another sporangium with stalk. × 150. (V.33835.)
FIG. 11. Part of another. × 400. (V.33835.)

All the above are from Bovey.

Potamogeton tenuicarpus C. & E. M. Reid

FIG. 12. An endocarp, side, with keel on the right beginning to gape. The seed (*s*), protrudes at the apex. × 15. (V.33836) Bovey.
FIG. 13. Another endocarp showing the gap between the ends of the curved carpel. × 15. (V.33837) Bovey.
FIG. 14. Pollen-grain probably belonging to this species. × 1000. J. B. Simpson Colln. Heathfield.

Stratiotes websteri (Brongniart)

FIG. 15. A seed, ventral side, (*c*) collar. × 6·5. (V.33838.)
FIG. 16. The same, dorsal, looking on to the keel. The specimen is somewhat crushed dorsiventrally. × 6·5.
FIG. 17. Part of a seed which has begun to split and burst. It shows the smooth rounded collar and the keel (*k*) arising out of it. × 6·5. (V.33839.)
FIG. 18. Valve of a seed, broken at the micropylar end, inner surface showing the short transverse raphe (*r*). × 6·5. (V.33840.)
FIG. 19. Another broken valve as in Fig. 18. × 6·5. (V. 33841.)

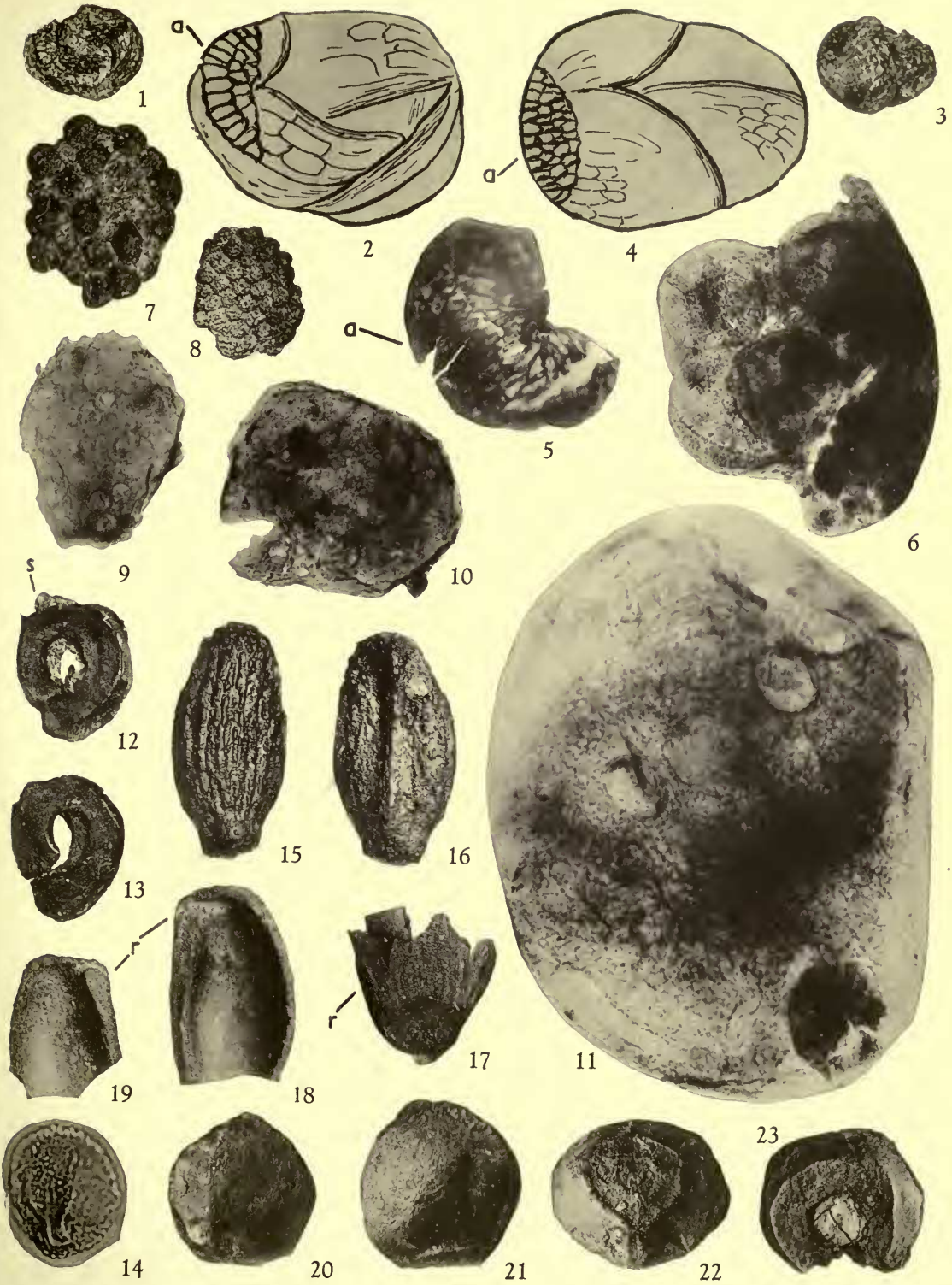
All the above are from Bovey.

Caricoidea nitens (Heer)

FIG. 20. A laterally compressed fruit, truncate at the base. Also figured Heer (1862, pl. 70, fig. 18). × 6 approx.
FIG. 21. Another fruit. The impression of the calyx is clearly seen in profile at the base. Also figured Heer (1862, pl. 70, fig. 16). × 6 approx.
FIG. 22. Base of a dorsiventrally compressed fruit showing the basal calyx scar in the centre of which is the plug closing the passage to the locule. × 6 approx.
FIG. 23. Holotype. Figured Heer (1862, pl. 70, fig. 20). A laterally compressed fruit from which a tangential slice had been cut to display the small locule. × 6 approx. (V.33842.)

All the above are from Bovey.

Figs. 8, 20–23 : *Photo C. Reid;* Figs. 9–11 : *Photo W. N. Croft;* Fig. 14 : *Photo J. B. Simpson.*



OSMUNDA, SALVINIA, POTAMOGETON, STRATIOTES, CARICOIDEA

PLATE 12

Calamus daemonorops (Unger)

FIGS. 24, 25. Two young fruits or female flowers showing three styles. × 15. (V.33846–47.)

FIG. 26. Somewhat older fruit; style bases are preserved but the three-fid style has disappeared. × 15. (V.33848.)

FIG. 27. A fruit showing clearly the inner and outer perianth segments. × 15. (V.33849.)

FIG. 28. A better developed fruit also showing the two whorls of persistent perianth segments. × 15. (V.33850.)

FIG. 29. Base of immature female fruit, the striate bracts in two whorls each of three bracts. × 15. (V.33851.)

FIG. 30. Small immature fruit showing overlapping reflexed scales. × 15. (V.33852.)

FIG. 31. A larger, better developed but much compressed fruit showing the overlapping reflexed scales. × 15. (V.33853.)

FIG. 32. The three-partite bract-like perianth of a male flower. × 15. (V.33854.)

FIG. 33, 34. Two more male flowers. × 15. (V.33855–56.)

FIG. 35. Fragment of a fruiting axis. × 6·5. (V.33857.)

FIG. 36. A smaller fragment of an axis. × 6·5. (V. 33858.)

FIG. 37. Immature seed extracted from a fruit. × 15·5 (V.33859.)

FIGS. 38–41. Spines and spine bases. × 2·8. (V.33860–63.)

FIG. 42. A pollen-grain (doubled on itself). × 1000. J. B. Simpson Colln.

FIG. 43. A crumpled immature seed possibly belonging to this species. × 15·5. (V.33864.)

FIG. 44. The same, opposite side. × 15·5.

All the above (except Figs. 37 and 42 from Heathfield) are from Bovey.

Myrica boveyana (Heer)

FIG. 45. An endocarp showing somewhat rugose surface. × 6·5. (V.33865.)

FIG. 46. A laterally flattened endocarp which may belong to this species. × 6·5. (V.33866.)

FIG. 47. One valve of an endocarp, internal surface, showing coat of equiaxial cells: (*f*) funicle, (*st*) stylar canal. × 15. (V.33867.)

FIG. 48. Neotype. Another valve from a broader fruit. Interior. Lettering as above. × 15. (V.33868.)

All the above are from Bovey.

Fig. 42 : *Photo J. B. Simpson.*

CALAMUS, MYRICA

Corylus sp.

FIG. 49. Fragment of an inflorescence of male flowers with anthers. × 15. (V.33869.) Heathfield.

FIG. 50. The same, opposite side. × 15.

FIG. 51. Pollen grain from the above. × 1000. J. B. Simpson Colln.

Carpinus boveyanus (Heer)

FIG. 52. Neotype. Fruit with accrescent calyx preserved showing longitudinal furrows associated with fibres which arise from the margin of the basal scar (*s*) of attachment to the wing-like bract. × 6·5. (V.33870.)

FIG. 53. Another longer, narrower fruit; (*s*) as above. × 6·5. (V.33871.)

FIG. 54. Another fruit. × 6·5. (V.33872.)

FIG. 55. Another. × 12. (V.33873.) Heathfield.

FIG. 56. Another. × 15. (V.33874.)

FIG. 57. A small fruit with remains of superior perianth at the apex of the accrescent calyx; one of the two styles is preserved. × 6·5. (V.33875.)

FIG. 58. A specimen with styles preserved. Perianth much worn. × 6·5. (V.33876.)

FIG. 59. A fruit, the lateral scar near the base indicates that it was one of a pair of fruits, the other being but little developed. × 12. (V.33877.) Heathfield.

FIG. 60. A twinned fruit. × 12. (V.33878.) Heathfield.

FIG. 61. A small twinned fruit. × 12. (V.33879.) Heathfield.

FIGS. 62–65. Four twinned fruits. In Fig. 62 part of the basal end of one of the pair is broken away exposing the locule. The upper part is splitting in the plane of symmetry. Fruits in Figs. 64, 65 very unequally developed. × 6·5. (V. 33880–83.)

FIG. 66. Base of dorsiventrally compressed fruit. *Carpinus*? × 6·5. (V.33884.)

FIG. 67. One valve (interior) of another dorsiventrally compressed fruit probably *Carpinus*. × 6·5. (V.33885.)

Fagus minima n. sp.

FIG. 68. Holotype. An endocarp: (*s*) basal scar of attachment. × 6·5. (V.33886.)

FIGS. 69, 70. Two endocarps. × 6. The figures are reproduced from C. & E. M. Reid (1910, pl. 16, figs. 67, 68). Geol. Surv. Mus. Colln. No. 76683.

Zelkova boveyana n. sp.

FIG. 71. Holotype. Endocarp, lateral aspect: (*st*) style, (*a*) attachment. × 15. (V.33887.)

FIG. 72. The same, marginal view. × 15.

FIG. 73. The same, as in Fig. 72 but more tilted to show the attachment (*a*). × 15.

Moroidea boveyana n. sp.

FIG. 74. Holotype. Fruit, side. The rounded base is broken, (*st*) style; (*f*) projection marking the point of entry of the funicle to the sub-apical placenta. × 15. (V.33888.)

Brasenia ovula (Brongniart)

FIG. 75. A somewhat crumpled and distorted seed showing longitudinal corrugations of the surface due to effects of contraction and alignment of the cells: (*e*) position of embryotega. × 15. (V.33889.) Heathfield.

Magnolia boveyana n. sp.

FIG. 76. Holotype. A seed, concave surface with raphe: (*ch*) chalaza. × 6·5. (V.33890.) Heathfield.

FIG. 77. The same, opposite convex surface. × 6·5.

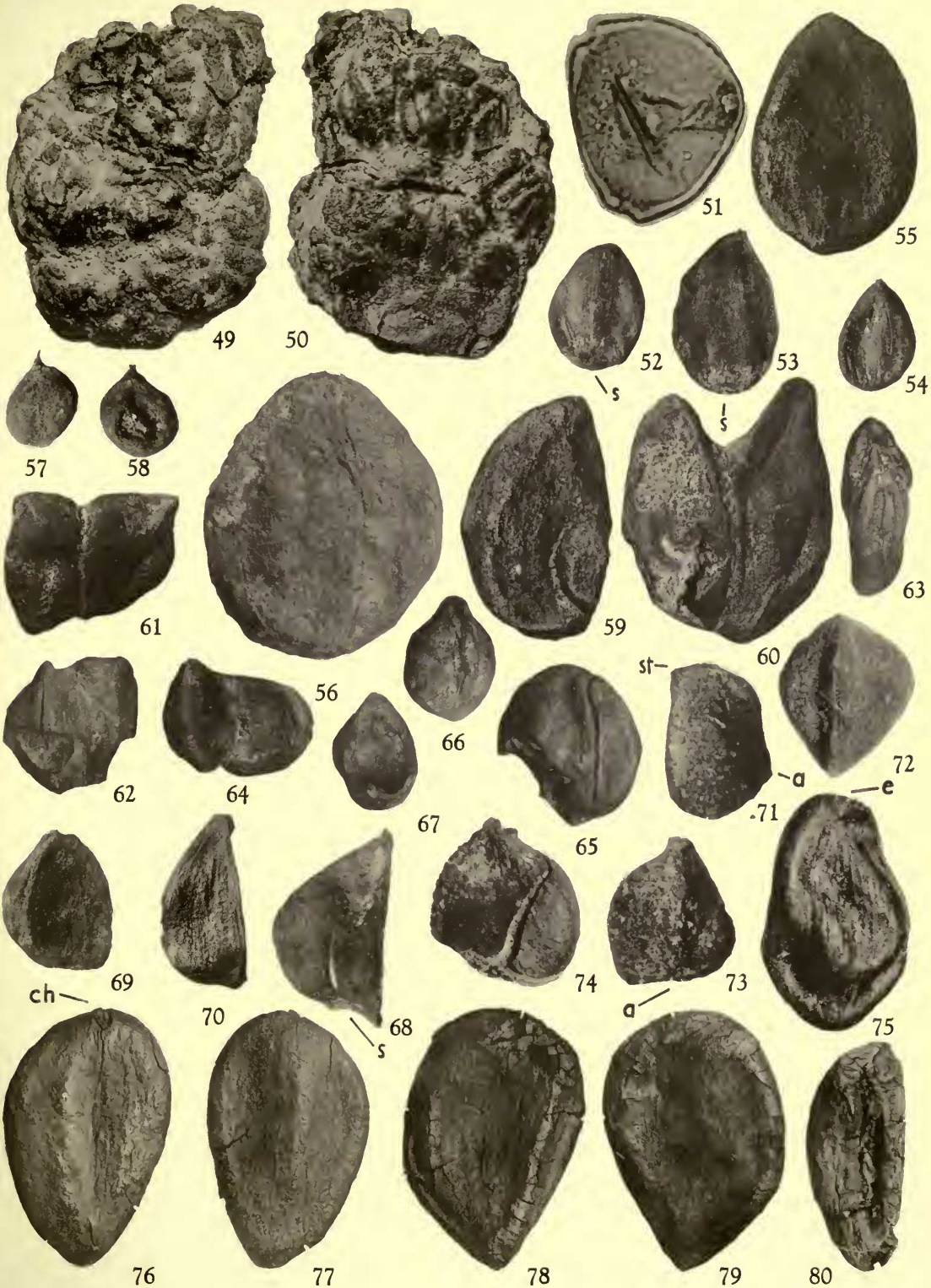
FIG. 78. Another seed, raphe side. × 6·5. (V.33891.) Heathfield.

FIG. 79. The same, opposite side. × 6·5.

FIG. 80. A seed longitudinally sectioned showing the canal (*ca*) through the chalaza-plug. × 6·5. (V.33892.) Heathfield.

Unless otherwise stated all the above are from Bovey.

Fig. 51: *Photo J. B. Simpson;* Figs. 55, 59–61, 70: *Photo C. Reid.*



CORYLUS, CARPINUS, FAGUS, ZELKOVA, MOROIDEA, BRASENIA, MAGNOLIA

PLATE 14

LAURACEAE

FIG. 81. An empty cupule with simple rim tilted to show the inner surface and scar of attachment of the berry. × 6·5. (V.33893.)
FIG. 82. Another. × 6·5. (V.33894.)
FIG. 83. A wrinkled leathery type of cupule with entire rim. × 6·5. (V.33895.)
FIG. 84. Leathery cupule with distinct sepals at the rim. × 6·5. (V.33896.)
FIG. 85. Another of similar type but much more slender. × 6·5. (V.33897.)
FIG. 86. Small cupule with distinct sepals enclosing berry. × 6·5. (V.33898.)
FIG. 87. Cupule with entire rim, berry enclosed. × 6·5. (V.33899).
FIG. 88. Small cupule with berry. × 6·5. (V.33900.) Bovey.
FIG. 89. A detached berry, imperfect below. × 6·5. (V. 33901.)
FIG. 90. Incomplete berry having glandular secretions beneath the skin. × 6·5. (V.33902.) Bovey.
FIG. 91. Another. × 6·5. (V.33903.) Bovey.

Unless otherwise stated all the above are from Heathfield.

Capparidispermum boveyanum n. sp.

FIG. 92. Holotype. A seed showing curved form and ornamentation: (*h*) hilum. × 15. (V.33904.)
FIG. 93. The same, opposite side. × 15.
FIG. 94. Another seed showing the hilar aperture (*h*) very clearly. × 15. (V.33905.)
FIG. 95. A larger but more compressed seed in which the cotyledonary limb is somewhat more incurled. × 15. (V.33906.)
FIG. 96. One valve of a seed, inner surface, showing the curved cavity. The form of the partition between the limbs is highly characteristic of Capparidaceae. × 15. (V.33907.)

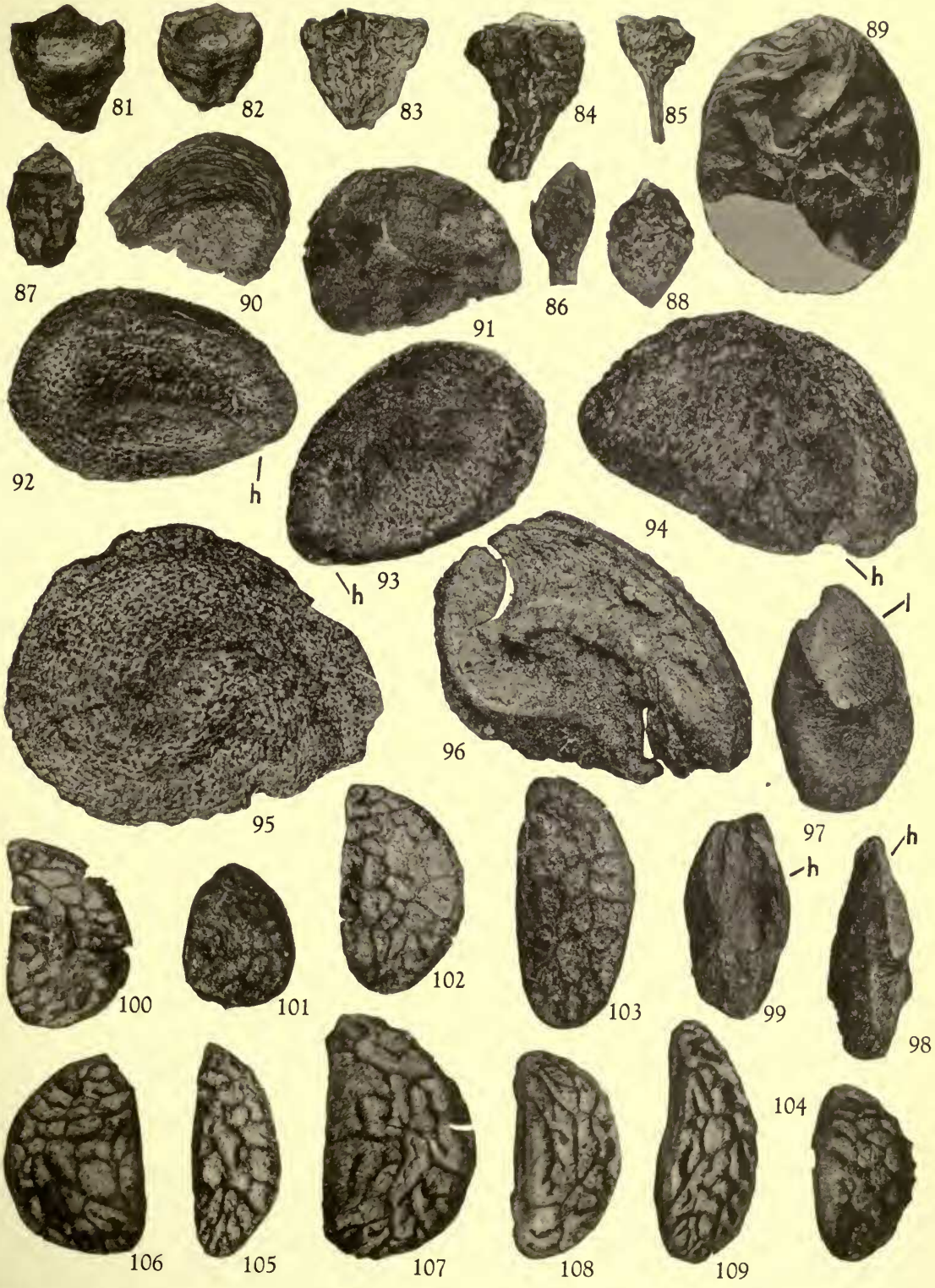
All the above are from Bovey.

HAMAMELIDACEAE Genus ?

FIG. 97. A seed, side, showing a lobe of the large hilar scar at (*l*). × 6·5. (V.33908.) Bovey.
FIG. 98. The same seed at right angles to Fig. 97. The hilar scar (*h*) crosses the proximal end of the seed and has a lobe on each of its broad faces. × 6·5.
FIG. 99. A seed of another species showing the long narrow hilar scar (*h*). At the opposite end of the seed a small portion of the septum between two locules adheres and shows a strand of fibres from the axis of the carpel. × 6·5. (V.33909.) Heathfield.

Rubus microspermus C. & E. M. Reid

FIGS. 100–105. Six endocarps showing variations in form and size. × 15. (V.33910–15.) Bovey.
FIGS. 106–109. Four endocarps. × 15. (V.33916–19.) Heathfield.



LAURACEAE, CAPPARIDISPERMUM, HAMAMELIDACEAE, RUBUS

Leguminosae Genus ?

Fig. 110. A crushed seed. × 6·5. (V.33920.)
Fig. 111. Another. × 6·5. (V.33921.)
Fig. 112. Part of a third seed showing hilum and the testa in section. × 6·5. (V.33922.)

The above are from Heathfield.

Meliosma reticulata (C. & E. M. Reid)

Fig. 113. Valve of an endocarp, external surface showing reticulations. × 6·5. (V.33923.)
Fig. 114. The same, interior : (*f*) funicular canal. × 6·5.
Fig. 115. Neotype. A perfect but laterally compressed endocarp. × 6·5. (V.33924.)
Fig. 116. The same, opposite surface. × 6·5.
Fig. 117. A dorsiventrally compressed endocarp, looking on to the attachment (centre of figure). × 6·5. (V.33925.)
Fig. 118. The lower part of one valve of an endocarp, interior showing the attachment and short funicular canal (*f*). × 6·5. (V.33926.)

All the above are from Bovey.

Parthenocissus britannica (Heer)

Fig. 119. Neotype. A typical seed, dorsal, showing long narrow chalaza. × 6·5. (V.33927.) Bovey.
Fig. 120. The same, ventral, showing lateral infolds diverging upwards. × 6·5.
Fig. 121. Another seed, dorsal. × 6·5. (V.33928.) Bovey.
Fig. 122. The same, ventral. × 6·5.

Parthenocissus boveyana n. sp.

Fig. 123. Holotype. Seed, dorsal. × 6·5. (V.33929.) Bovey.
Fig. 124. The same, ventral. × 6·5.
Fig. 125. Another seed with outer coat removed, dorsal (base broken). × 6·5. (V.33930.) Bovey.

Vitis hookeri Heer

Fig. 126. Seed (imperfect above on the left), dorsal × 6·5. (V.33931.) Heathfield.
Fig. 127. The same, ventral. × 6·5.

Vitis stipitata n. sp.

Fig. 128. Seed (imperfect on the left), dorsal. × 6·5. (V.33932.) Heathfield.
Fig. 129. The same, ventral. × 6·5.

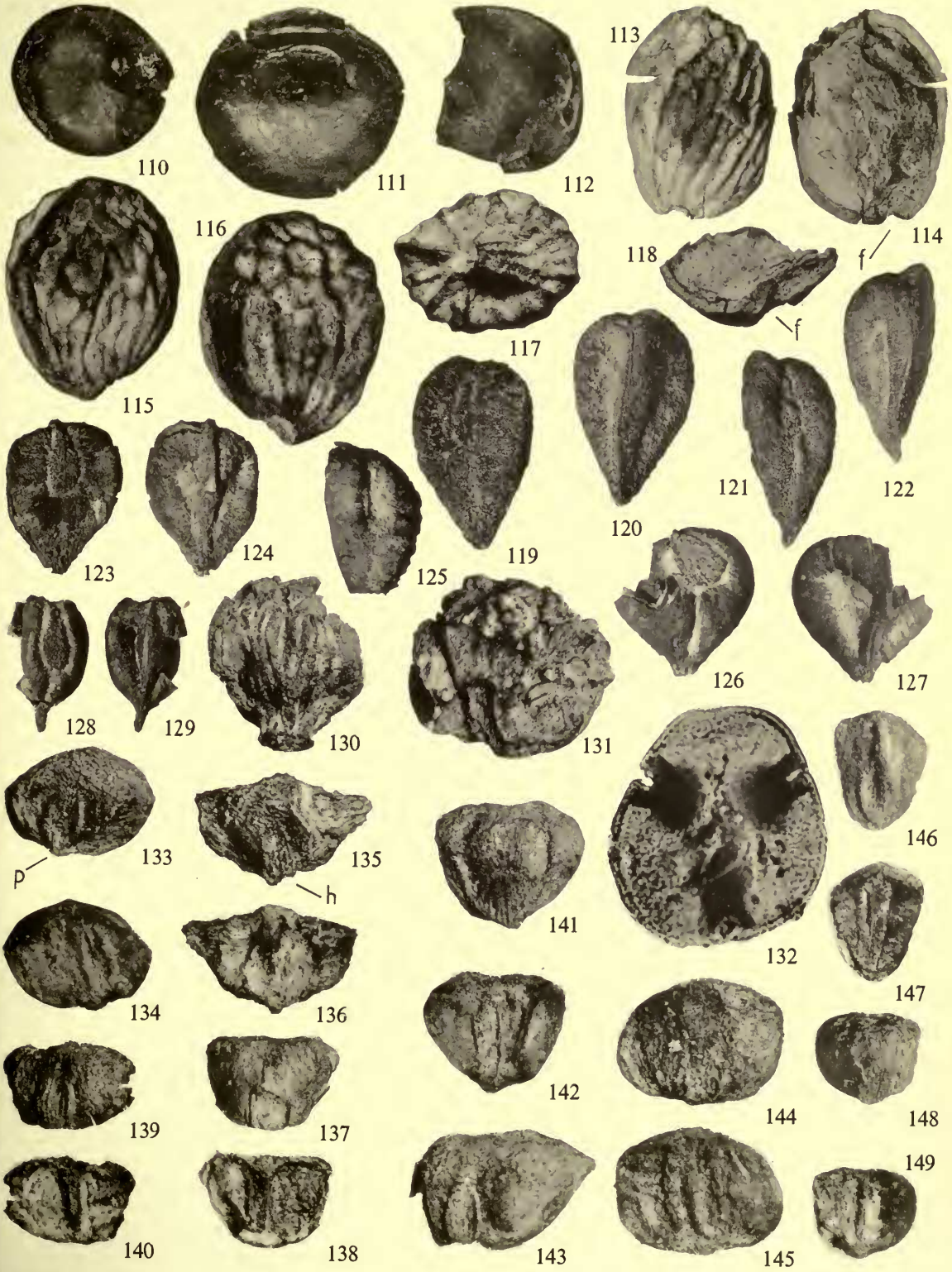
Tilia sp.

Fig. 130. A group of anthers. × 15. (V.33933.)
Fig. 131. Another group of anthers. × 15.
Fig. 132. A pollen grain from anthers in Fig. 131. × 1000. J. B. Simpson Colln.

The above are from Heathfield.

Microdiptera parva n. gen. et sp.

Fig. 133. Seed, dorsal, with pitted oval germination valve and striate wing surface. × 15·5. (V.33934.)
Fig. 134. The same, ventral, showing median longitudinal raphe ridge also a furrow on each side of it flanked by a wing. × 15·5.
Fig. 135. Seed with pointed wings, dorsal : (*h*) hilum. × 15·5 (V.33935.)



LEGUMINOSAE, MELIOSMA, PARTHENOCISSUS, VITIS, TILIA, MICRODIPTERA

Fig. 136. The same, ventral. × 15·5.

Fig. 137. Seed, dorsal. The germination valve has come away and the cavity is full of sand. × 15·5. (V.33936.)

Fig. 138. The same, ventral, showing wings and raphe ridge very clearly. × 15·5.

Fig. 139. Seed, dorsal, pitted valve very clear. × 15·5. (V.33937.)

Fig. 140. Same, ventral. × 15·5.

Fig. 141. Seed, dorsal. ×15·5. (V.33938.)

Fig. 142. Same, ventral. Cavities flanking raphe ridge show clearly as they are filled with sand. × 15·5.

Fig. 143. Seed with asymmetrically developed wings and clearly defined valve beginning to gape. × 15·5. (V.33939.)

Fig. 144. Seed, dorsal. Symmetric wings show striations very clearly. × 15·5. (V.33940.)

Fig. 145. Same, ventral. × 15·5.

Fig. 146. Small narrow seed, dorsal. × 15·5. (V.33941.)

Fig. 147. Same, ventral. × 15·5.

Fig. 148. Small seed, dorsal. × 15·5. (V.33942.)

Fig. 149. Same, ventral. × 15·5.

All the above are from Bovey.

Fig. 132 : *Photo by J. B. Simpson.*

Nyssa boveyana n. sp.

FIG. 150. Holotype. Endocarp, dorsal, showing the valve (*v*). × 6·5. (V.33944.)
FIG. 151. Same, ventral. × 6·5.
FIG. 152. Another endocarp, dorsal, valve beginning to open. × 6·5. (V.33945.)
FIG. 153. The same, ventral. × 6·5.
FIG. 154. An endocarp, dorsal, valve detached exposing part of locule. × 6·5. (V.33946.)
FIG. 155. The valve removed from the above. × 6·5.
FIG. 156. Apical end of an endocarp showing valve in position exceptionally clearly. × 6·5. (V.33947.)
FIG. 157. A large laterally compressed endocarp. × 6·5. (V.33948.)
FIG. 158. Detached valve from endocarp of *Nyssa sylvatica* var. *europaea* for comparison. × 6·5. (V.33949.) Pliocene ; Reuver.
FIG. 159. Detached valve from *N. sylvatica* var. *biflora* for comparison. × 6·5. Recent.

Myrtospermum boveyanum n. sp.

FIG. 160. Holotype. Seed showing curved form and characteristic pitting. × 15. (V.33950.)
FIG. 161. Typical seed, usual preservation, showing indications of curved form and condyle between the limbs. × 15. (V.33951.)
FIG. 162. Same, opposite side. × 15.
FIG. 163. Another seed with clear indications of curved cavity. × 15. (V.33952.)
FIG. 164. Seed showing clear indications that the pits were originally inflated. × 15. (V.33953.)
FIG. 165. Somewhat distorted seed. × 15. (V.33954.)
FIG. 166. Incomplete seed, internal surface of one valve showing condyle : (*h*) hilum leading into raphe cavity in condyle. Structures are rarely seen in these highly compressed seeds of which the valves are reluctant to separate. × 15. (V.33955.)
FIG. 167. Two closely adpressed seeds in position of growth, one ? abortive. × 15. (V.33956.)
FIG. 168. The same pair of seeds, opposite side. × 15.

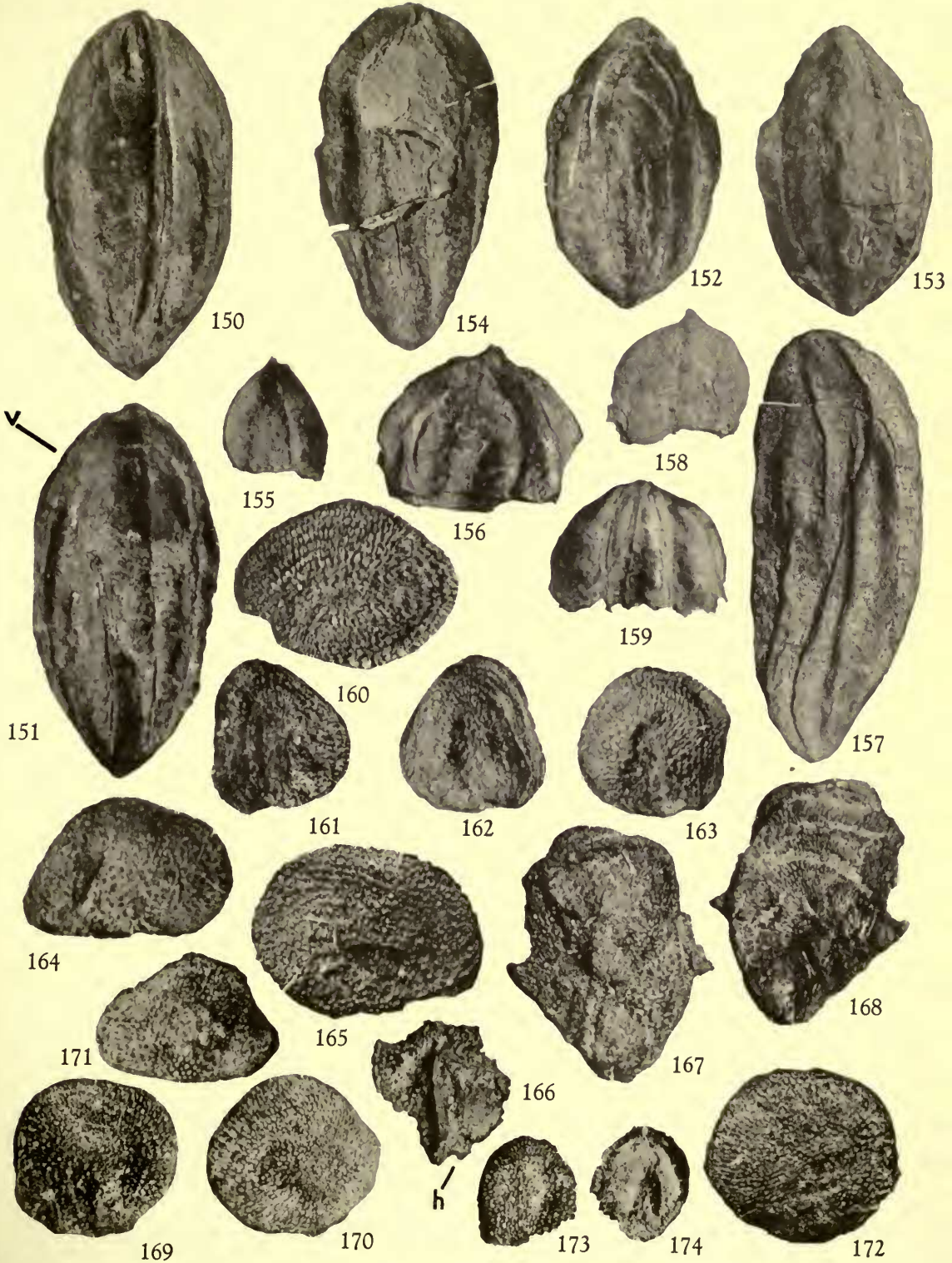
Myrtospermum dubium n. sp.

FIG. 169. Sub-circular seed. × 15. (V.33957.)
FIG. 170. Opposite side of same seed. × 15.
FIG. 171. Seed of irregular form. × 15. (V. 33958.)
FIG. 172. Another somewhat larger seed. × 15. (V.33959.)

Myrtospermum sp.

FIG. 173. Seed, imperfect at hilar end. × 15. (V.33960.) Heathfield.
FIG. 174. One valve of the above, internal surface, showing curved cavity, broad triangular canal in condyle and columnar testa cells as seen in section. × 15.

Unless otherwise stated all the above are from Bovey.



NYSSA, MYRTOSPERMUM

Mastixia boveyana n. sp.

FIG. 175. Holotype. One end of an endocarp. × 6·5. (V.33961.)
FIG. 176. Opposite aspect of same fragment showing locule in transverse section with its valve and infold. × 6·5.
FIG. 177. One end of another endocarp, side. × 6·5. (V.33962.)
FIG. 178. Fragment of endocarp, external surface, at about the middle showing ribbing. × 6·5. (V.33963.)

The above are from Heathfield.

Lysimachia boveyana n. sp.

FIG. 179. Holotype. Seed, ventral, showing two facets and ridge on which the attachment lies. × 28. (V.33964.)
FIG. 180. The same, dorsal. The longitudinal shadow marks a crack in the testa. × 28.

Symplocos anglica n. sp.

FIG. 181. Holotype. An endocarp somewhat compressed and showing the apical depression. × 6·5. (V.33965.)
FIG. 182. Endocarp, side, slightly distorted so as to show part of the apical depression. × 6·5. (V.33966.)
FIG. 183. The same, more tilted, so as to show the three apical apertures. × 6·5.
FIG. 184. Another, side, showing truncated apex and wrinkled surface. × 6·5. (V.33967.)
FIG. 185. Small endocarp, distorted so that two of the three apical apertures are shown. × 6·5. (V.33968.)
FIG. 186. A broader endocarp, probably belonging to this species. × 6·5. (V. 33969.)

Symplocos headonensis Chandler

FIG. 187. Endocarp somewhat distorted so as to show the apex with four apertures. × 6·5. (V.33970.)
FIG. 188. Another, side. The apical depression is seen in profile. × 6·5. (V.33971.)

All the above are from Bovey.

Solanispermum reniformis n. gen et sp.

FIG. 189. Perfect seed. × 6. Geol. Surv. Mus. Colln. No. 76684.
FIGS. 190–191. Two fragments of one seed which broke on removal from the matrix. × 15·5. (V.33972.)

Carpolithus spp.

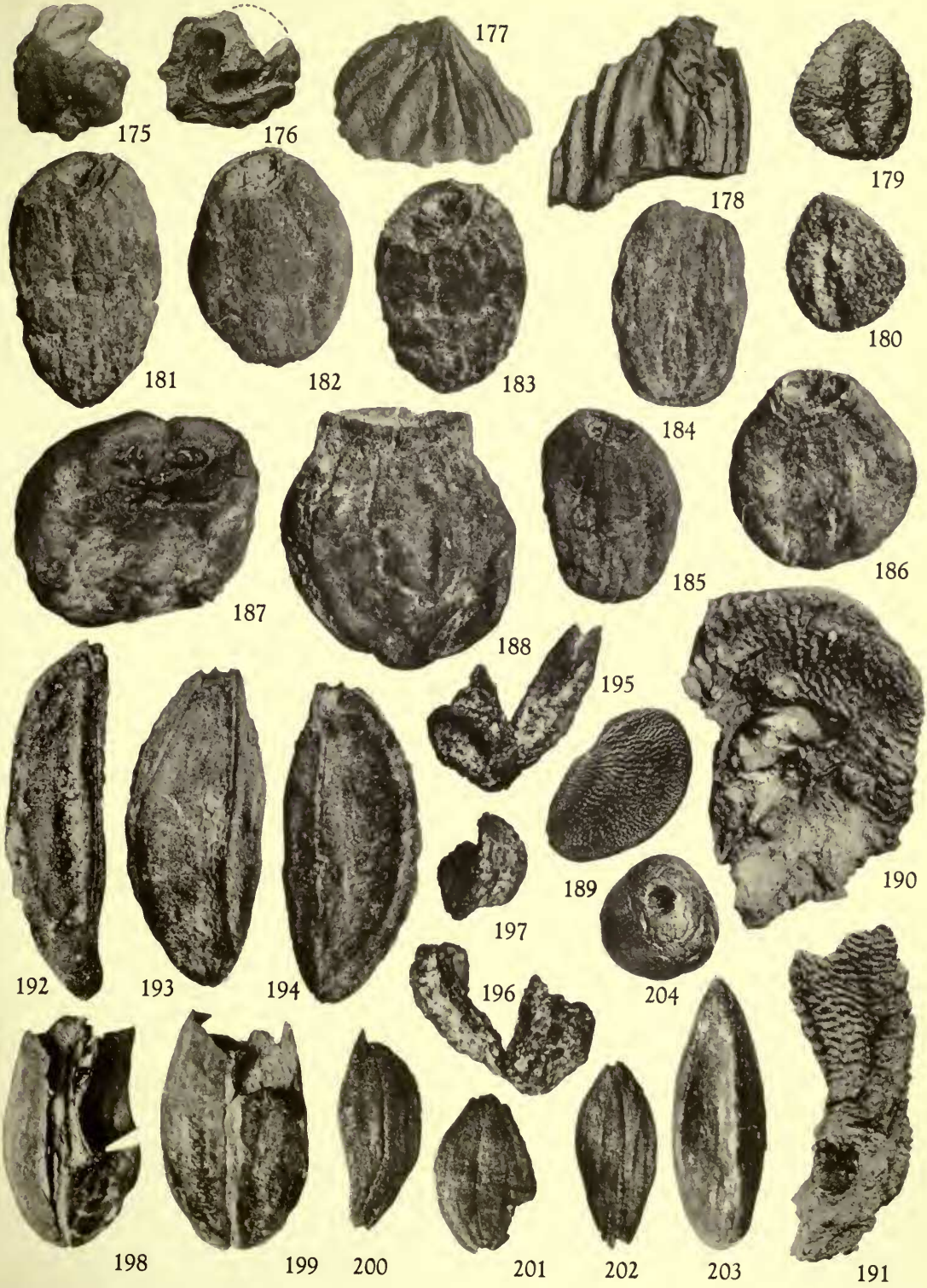
FIG. 192. A carpel, side, showing one of the ventral facets. Ventral angle on the right. Note three-fid perianth at apex. × 15. (V.33973.) Heathfield.
FIG. 193. Another, dorsal side, dorsiventral compression shows part of one of the ventral facets on the right. × 15. (V.33974.) Heathfield.
FIG. 194. The same, ventral side, showing two facets and ventral angle. Persistent superior perianth can be seen. × 15.
FIG. 195. Two lobes of a dehisced capsule, inner surface. × 8. (V.33975.)
FIG. 196. The same, outer surface. × 8.
FIG. 197. Outer surface of a third detached lobe from the same specimen. × 8.
FIG. 198. Endocarp, incomplete at one end, broken so as to show one of the septa. × 6·5. (V.33976.) Heathfield.
FIG. 199. Another, broken at one end. × 6·5. (V.33977.)
FIG. 200. A three-lobed slender fruit. × 6·5. (V.33978.)
FIG. 201. Another somewhat broader specimen. × 6·5. (V.33979.)
FIG. 202. Another fruit with three minute patent perianth segments. × 6·5. (V.33980.)
FIG. 203. A seed. × 15·5. (V.33981.)

Bulbil ?

FIG. 204. Bud or Bulbil. The large hollow may be the burrow of an insect. × 2·8. (V.33982.)

Unless otherwise stated all the above are from Bovey.

Fig. 189 : *Photo by C. Reid.*



MASTIXIA, LYSIMACHIA, SYMPLOCOS, SOLANISPERMUM, CARPOLITHUS, BULBIL?